State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife Resources - Native Aquatic Species

Columbia Spotted Frog (*Rana luteventris*) Statewide Monitoring Summary, 2007-2008

Publication Number 09-32
Utah Division of Wildlife Resources
1594 West North Temple
Salt Lake City, Utah
James F. Karpowitz, Director

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SPOTTED FROG SUMMARY

This report summarizes the Columbia spotted frog (*Rana lutieventris*) surveys and monitoring activities performed by the Utah Division of Wildlife Resources' Northern, Central, and Southern regions during the 2007 and 2008 field seasons. Spotted frog populations are separated into three Geographic Management Units (GMUs) and ten hydrologic unit codes (HUCs) in the State of Utah. The Northern and Central regions survey activities occurred in all three GMUs (Wasatch Front, Sevier River, and West Desert). These GMUs included the following HUCs: Spanish Fork River, Utah Lake, Provo River, Jordan River, Upper Weber River, and Lower Weber River (Wasatch Front GMU); San Pitch River (Sevier River GMU); and Ibapah Valley, Snake Valley, and Tooele Valley (West Desert GMU; Report I). Monitoring units for the Southern Region (Report II) are located only in the West Desert GMU and included: Snake Valley and Tule Valley.

In general, surveys were performed statewide between 6 March and 27 May, 2007 and 2008. Surveys were conducted using visual encounter surveys (VES) on spotted frog egg masses. Information pertaining to the presence of *Batrachochytrium dendrobatidis* (chytrid) on adult and metamorphs is presented by the Northern and Central Region Report (Report I). Finally, multiple reports contain information pertaining to translocation efforts, recommendations for future inventory efforts, habitat restoration efforts, and non-native species removal. The reports presented here were written separately for 2007 and 2008 by each region and combined here for simplicity. For consistency, reports compiled here follow a common page, table, and to a lesser degree figure layout; however, individual reports retain the authors' style and formatting structure.

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I-Northern & Central Region Report

By:
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INTRODUCTION

The Columbia spotted frog (*Rana luteiventris*) is distributed from southeastern Alaska to Oregon and western Wyoming with isolated populations existing in Utah and Nevada. Historically, Columbia spotted frog populations were common throughout the Bonneville Basin. The distribution declined following the recession of Lake Bonneville, resulting in the isolation of several remaining populations (Hovingh 1993). Today, many of these historic populations have been extirpated and the remaining populations are vulnerable to a variety of physical and biological impacts (Perkins and Lentsch 1998).

The Utah Division of Wildlife Resources (UDWR) monitors Columbia spotted frog populations to document population trends, determine current distribution, and identify suitable potential habitat. Monitoring takes place annually during the spring breeding season at breeding sites documented during surveys conducted in previous years (Ross et al. 1993; Wilson and Olsen 2001; Thompson et al. 2003). The estimated size of a Columbia spotted frog population is based on the number of egg masses counted during the breeding season (Ross et al. 1993; Ross et al. 1994). An egg mass represents the reproductive efforts of one male and one female Columbia spotted frog, therefore the number of breeding adults in a population can be estimated by doubling the number of observed egg masses. The estimates are then used to examine population trends based on annual fluctuations. The monitoring program also provides baseline data for development of management plans to accomplish the goals outlined in the Conservation Agreement and Strategy for Columbia Spotted Frog in the State of Utah (Bailey et al. 2006).

Columbia spotted frog populations in Utah are separated into three Geographic Management Units (GMU) (Bailey et al. 2006). GMUs are divided into subunits based on United States Geological Survey (USGS) hydrologic subunits and totaled eight unit hydrologic units codes (HUC); only those subunits within the Northern and Central regions of Utah are discussed in the following report.

METHODS

Study Area

The study areas consisted of three GMUs and eight HUCs. The GMUs and their affiliated HUCs (in parentheses) included: The Wasatch Front GMU (Spanish Fork River, Utah Lake, Provo River, Jordan River, Upper Weber River, and Lower Weber River); The Sevier River GMU (San Pitch River); and The West Desert GMU (Ibapah Valley, Snake Valley, and Tooele Valley).

Wasatch Front GMU

Spanish Fork River, 16020202: Three Columbia spotted frog populations are known to occur within the subunit: Holladay Springs, Springville Hatchery, and Diamond Fork Canyon. The Diamond Fork population was first documented in 2002 (Wilson et al. 2003) and was first included in annual monitoring in 2003.

Utah Lake, 16020201: The subunit includes two Columbia spotted frog populations in Juab County: One population is located at Mona Springs (part of the Burraston Ponds Wildlife Management Area) and the other is located in wetlands South of Burraston Ponds (hereafter referred to as the South of Burraston population). New breeding sites were located within the South of Burraston population during sweep surveys conducted in 1999 (Wilson and Olsen 2001); the sites have since been included in annual monitoring efforts.

Provo River, 16020203: Two Columbia spotted frog populations occur within the subunit: one is found in the riparian floodplain along the Provo River above Jordanelle Reservoir (Upper Provo), and the other occupies wetlands along the Provo River between Jordanelle and Deer Creek reservoirs (Heber Valley population). Additional breeding sites have been located within the Upper Provo population during sweep surveys conducted since 1999 (Wilson and Olsen 2001, Thompson et al. 2003). These new breeding sites have been included in annual monitoring surveys.

Jordan River, 16020204: The Jordan River hydrologic unit was surveyed in 1992 by Ross et al. (1993) but no egg masses were found. No surveys have been conducted in the Jordan River drainage in subsequent years.

Upper Weber River, 16020101: The Upper Weber River subunit contains one known Columbia spotted frog population located on the Swaner Nature Preserve. Columbia spotted frogs historically existed within the subunit, but the current population was established as a result of repatriation efforts conducted by Brigham Young University, UDWR, and the Columbia Spotted Frog Conservation Team (Belk and Harvey 2005).

Lower Weber River, 16020102: Only one adult Columbia spotted frog has been documented within the subunit. The individual was found in the Farmington Lakes complex during 1996 by the UDWR (Thompson and Schmitz 1998). Surveys in the complex during 2001 and 2002 did not confirm the presence of any additional Columbia spotted frogs.

Sevier River GMU

The Sevier River GMU consists of three USGS hydrologic subunits (San Pitch River, Middle Sevier, and Lower Sevier), but currently Columbia spotted frog populations only exist in the San Pitch River subunit.

San Pitch River, 1603004: The subunit contains the Fairview Columbia spotted frog population, which includes 11 breeding sites that have been monitored annually since 1992. Fifteen new sites were found during sweep surveys conducted in 1999-2000 and have been added to annual monitoring surveys (Wilson and Olsen 2001).

Middle Sevier River, 16030003: Columbia spotted frogs have not been documented in this subunit.

Lower Sevier River, 16030005: Columbia spotted frogs have not been documented in this subunit.

West Desert GMU

The West Desert GMU contains seven hydrologic subunits, six of which are covered in the following report.

Ibapah Valley, 16020306: The subunit contains a large population of Columbia spotted frogs distributed throughout the Ibapah Valley. Two monitoring sites were established in 1997 to represent different habitat types in the valley. The south monitoring site is typified by natural spring sources while the historic north monitoring site (North #1) is pastureland that is artificially flooded. In 2006 a new breeding site (North #2), with a less modified hydrology was discovered 2 km north of the historic monitoring site. We will continue to monitor the historic southern site and the new northern site (North #2) in the future.

Snake Valley, 16020301: The border between the UDWR Central and Southern regions bisects Snake Valley. The Central Region monitors the Leland Harris and Miller Springs populations. The Southern Region monitors the Gandy and Bishop Springs populations.

Tooele Valley, 16020304: One Columbia spotted frog population is located within this subunit near the town of Vernon. The population was located during sweep surveys conducted in 2002 (Wilson et al. 2003) and has been monitored annually since.

Skull Valley (16020305), West Great Salt Lake (16020308), and North Great Salt Lake (16020309): Columbia spotted frogs have not been documented in these subunits.

Breeding Onset

Sentinel sampling will be conducted at representative (sentinel) sites within each subunit to determine the onset of Columbia spotted frog breeding. Sentinel sites are a subset of egg deposition areas which are consistently utilized by Columbia spotted frogs despite seasonal variation in habitat. Onset of breeding is dependent on several factors (e.g., temperature and hydrology), but onset of breeding within each population is relatively consistent (Table 1). To insure accurate identification of onset, monitoring of sentinel sites will start approximately seven to ten days before the historic mean onset date (Table 1). Sentinel sampling will follow visual encounter survey (VES) protocols discussed below.

Monitoring

Historic breeding sites were surveyed weekly during the breeding season to collect information on the number of egg masses deposited and the development and metamorphosis of tadpoles. Egg mass surveys were conducted according to a VES protocol where the shoreline of potential breeding habitat is searched for egg masses, and survey time is recorded as a measure of survey effort (similar to Crump and Scott 1994). All potentially suitable breeding habitats within a region are surveyed (see Ammon et al.

2001 for a detailed description of preferred habitat). Surveys are typically conducted from the shoreline, but in some cases, suitable habitat is most easily surveyed by wading through the deeper parts of the wetland and viewing the shallow shorelines.

Upon locating an egg mass, the numbers of egg masses within the cluster were recorded. Each egg mass deposition site was visited weekly thereafter to record the developmental stage of preexisting masses and to record any newly laid masses. Upon locating an egg mass, the developmental stages of embryos are categorized into one of five stages: *age class 1* – egg mass below surface of water and resting on substrate or vegetation, envelopes clear and ova small, dark, and circular; *age class 2* – egg mass beginning to float to surface, envelopes opaque and ova kidney shaped or elongated; *age class 3* – egg mass floating at surface of water with top layer of eggs appearing whitish and desiccated, embryos have tails and appear close to hatching; *age class 3+* – egg mass starting to disarticulate and often yellow in color, half or more of the embryos have hatched and are feeding on the mass or swimming freely as tadpoles; and *dead* – embryos white, with disarticulation of both the embryos and the egg mass.

Each egg deposition site was visited weekly thereafter with only new egg masses within the cluster being counted. The number of egg masses observed during the breeding season is doubled to obtain an estimate of the effective population size of spotted frogs (N_e = the number of breeding individuals that contribute to the reproductive effort for the year). Estimates of the date of breeding onset and peak breeding are based on the number of new egg masses, total egg masses, and the development stage of each. Dates are provided to serve as an approximate reference for each event and it should be recognized the exact date of each event is impossible to calculate without daily visits to each location.

In an attempt to locate new Columbia spotted frog populations outside designated monitoring sites, sweep surveys were conducted by traversing the perimeter of ponds and other wetlands while looking for amphibians and egg masses. In ponds with extensive aquatic vegetation, care was taken while walking through the vegetation to avoid harming egg masses and/or frogs. In bogs and willow thickets, researchers spread out and make broad zigzags through the site to ensure proper coverage of the area. If frogs, tadpoles, or egg masses are observed, their locations are recorded using a handheld GPS unit. Sweep surveys are generally conducted in areas surrounding or connected to currently occupied sites, as well as areas that were historically occupied by Columbia spotted frog.

Data Entry

Egg mass and adult locations were recorded on digitized site maps or aerial photos and further documented through the collection of UTM coordinates using a handheld GPS unit. Additional data on the number of egg masses in a given location, their stage(s), and other relevant information were clearly recorded on standardized datasheets. All pertinent data was entered into Excel or Access spreadsheets and subsequently reported in annual monitoring reports

Heber Valley Monitoring
Currently, the Columbia spotted frog population in the Heber Valley is monitored by the Utah Reclamation Mitigation and Conservation Commission (URMCC) and the UDWR. The cooperative monitoring effort seeks to achieve the following two goals: (1) to evaluate population responses to habitat that was created or enhanced during the Provo River Restoration Project (PRRP); and (2) to determine Columbia spotted frog movements in natural conditions, in relation to newly created habitat, and in response to artificial relocation.

Heber Valley monitoring protocols differ from general monitoring protocols in the following ways. All suitable habitats are surveyed approximately seven days and 14 days following breeding onset. UTM coordinates of each egg mass are recorded and entered into an ArcView database along with information on egg mass numbers per cluster and developmental stage. In addition to UTMs, the general location of each egg mass is marked on digitized aerial photographs. Subsequent visits documented development, survivorship, and additional egg masses.

Chytrid Monitoring
In the fall of 2001 *Batrachochytrium dendrobatidis* (*Bd*) was detected in Columbia spotted frogs in three separate locations in the Heber Valley resulting in the initiation of a *Bd* monitoring plan. *Bd* infects only the keratinized epithelium of amphibians, limiting it in tadpoles to their mouthparts. Columbia spotted frog tadpoles without *Bd* exhibit well-defined black and bilaterally symmetrical oral-disk, jaw sheath (beak), and tooth rows (2-3 upper, 2 lower). *Bd* infects the tadpole's loose pigmentation in portions of their tooth rows and jaws. Depigmentation may also be accompanied by redness, swelling, and physical abnormalities in more advanced cases (Fellers et al. 2001). Such deformities can result in low feeding rates and other symptoms which may eventually cause mortality and/or malnourishment (Blaustein et al. 2005).

In 2007, a total of 526 tadpoles from the Heber Valley were examined for tooth row and jaw sheath depigmentation and abnormalities. Tadpoles were captured using a hand-held dip net or mesh minnow trap and observed with a 10X or 16X magnification hand lens. Examination was conducted before tadpoles began to metamorphose as the beak and tooth rows lose pigment with the transformation of the mouth. Degree of abnormality and pigmentation were classified into one of three categories; *normal*-no depigmentation or missing tooth rows, *slight*-less than 50% pigmentation missing from tooth row/jaw and/or less than 50% of tooth row affected by an abnormality (missing, crooked, etc), or *severe*-more than 50% of tooth row/jaw missing pigmentation and/or more than 50% of tooth row/jaw affected by an abnormality.

A random sample of 48 tadpoles from the Heber Valley were examined for mouthpart abnormalities and depigmentation (as described above), assigned inventory numbers, and sent to the UDWR Fisheries Experiment Station (FES) (Logan, Utah) for *Bd* infection analysis using a polymerase chain reaction based assay (Annis et al. 2004). Sensitivity, specificity, and true and observed prevalence of *Bd* results via mouthpart analysis will then be compared to PCR results.

In 2008, approximately 75 Columbia spotted frogs were tested for *Bd*. The feet and ventral surfaces of each individual were swabbed with a Medical Wire and Equipment Company type MW100 fine tip cotton swab (following Hyatt et al. 2007). Sample information including species, snout vent length, date, site location, and UTM coordinates were recorded on each swab case and also entered into an Excel spreadsheet. Samples were analyzed by Pisces Molecular (2200 Central Avenue, Suite F Boulder, CO 80301) and FES utilizing PCR analysis (Annis et al. 2004).

Pathogen and Biosecurity Measures

With the presence of *Bd*, *Ranavirus,* and other pathogens in Utah and the high probability of anthropogenic transportation of pathogens, (Daszac et al. 2001; Docherty et al. 2003; Jancovich et al. 2005) a disease prevention protocol was followed when conducting field research. Prior to leaving a site, all mud and debris was removed from boots and equipment and then rinsed with clean water. Quat 128 (a quaternary ammonia compound) was next applied as a 1:100 solution, as a disinfecting agent, to boots, nets, and other equipment by either spraying or submerging in a bath. Multiple sets of waders and other equipment were also utilized to allow gear completely dry between sites.

RESULTS

2007 Monitoring

Wasatch Front GMU

Spanish Fork River: Weekly monitoring began on 13 March and continued until 16 April (Table 2). A total of 107 egg masses were observed in the Spanish Fork River subunit: zero at Holladay Springs, 15 egg masses at Springville Hatchery, and 92 egg masses at Diamond Fork (Figure 1).

No egg masses were observed at Holladay Springs despite multiple surveys. Eggs were first observed at the Springville Hatchery on 24 March, the breeding season peaked two weeks later on April 5. Egg masses first appeared at Diamond Fork the week of 17 April and peaked the same week (Table 2). One head-start project was planned at Holladay Springs but no egg masses were discovered during the breeding seasons.

Utah Lake: Weekly monitoring of the Utah Lake subunit began on 13 March and continued until 12 April (Table 2). A total of 88 egg masses were observed in the Utah Lake subunit; 33 at the Mona Springs population and 55 within the South of Burraston complex (Figure 2). Eggs were first discovered at Mona Springs on 11 March, the breeding season peaked approximately two weeks later on 23 March. Eggs were first observed at the South of Burraston complex on 18 March and peaked within the same week (Table 2).

Provo River: The Provo River Subunit is divided into two populations, the Heber Valley and the Upper Provo. Weekly monitoring within the Heber Valley population began on 26 March and continued to 18 April (Table 2). Egg masses were first discovered within the lower reaches of the Heber Valley population on 24 March and breeding peaked

approximately 11 days later on 4 April. A total of 800 egg masses were observed within the Heber Valley (Figure 3). The lower reaches (1-4) had 206 egg masses, accounting for 25.75% of the total egg masses observed in the Provo River. The middle reaches (5-6) had 22 egg masses (2.75%), and the upper reaches (7-9) had 572 egg masses (71.5%).

Monitoring of the Upper Provo River population began on 2 April and continued until 27 April. Egg masses were first reported on 31 March and peaked on approximately 11 April (Table 2). With the combined efforts of the Central and Northern Regions of the DWR a total of 559 egg masses were observed within the Upper Provo River population (Figure 4).

Jordan River: No surveys were conducted in the Jordan River subunit in 2007.

Upper Weber: One survey of the Swaner Nature Preserve repatriation site was conducted in 2007. No Columbia spotted frogs or egg masses were observed.

Lower Weber: No surveys were conducted in the Lower Weber subunit in 2007.

Sevier River GMU

San Pitch River: Monitoring of the Fairview population within the San Pitch River Subunit began on 22 March and continued through 18 April. The first egg masses were estimated to be laid on 20 March and breeding likely peaked during the same week (Table 2). A total of 31 egg masses were observed within the subunit (Figure 5).

West Desert GMU

Ibapah Valley: Monitoring within the Ibapah Valley commenced on 29 March and continued through 17 April (Table 2). Egg masses were first observed within the Ibapah Valley on 1 April and breeding is estimated to have peaked five to seven days later. A total of 229 egg masses were observed within the subunit (South n=155, New North n=74) (Figure 6).

Snake Valley: Monitoring within Snake Valley was conducted from 1 March through 10 April with a total of 487 egg masses observed (Table 2). Egg masses within the subunit were spread amongst Leland Harris (n=241) and Miller Springs (n=246) (Figure 7). Breeding at both sites began the week of 13 March. Breeding peaked at Leland Harris on approximately 16 March, and peaked at Miller Springs on approximately 28 March.

Tooele Valley: Monitoring within the Tooele Valley began on 23 March and continued until 10 April (Table 2). For the third year in a row no egg masses or adults were observed (Figure 8). Sweep surveys were also conducted within the subunit at the Fitzgerald Wildlife Management Area (Atherly Reservoir) near Faust, Utah. No Columbia spotted frog egg masses or adults were detected during the survey.

2008 Monitoring

Wasatch Front GMU

Spanish Fork River: Weekly monitoring began on 4 March and continued until 28 April (Table 3). A total of 89 egg masses were observed in the Spanish Fork River subunit: two at Holladay Springs, ten egg masses at Springville Hatchery, and 77 egg masses at Diamond Fork (Figure 1).

Two egg masses at were observed at Holladay Springs on April 4. Eggs were first observed at the Springville Hatchery on 16 April and it is estimated the breeding season peaked approximately two weeks earlier on 1 April. Egg masses first appeared at Diamond Fork the week of 4 April and peaked the same week (Table 3).

Utah Lake: Weekly monitoring of the Utah Lake subunit began on 19 March and continued until 30 April (Table 3). A total of 99 egg masses were observed in the Utah Lake subunit; 58 at the Mona Springs population and 41 within the South of Burraston complex (Figure 2). Eggs were first discovered at Mona Springs on 31 March, it is estimated breeding season peaked approximately a week later. Eggs were first observed at the South of Burraston complex on 14 April and breeding is estimated to have peaked within the same week (Table 3).

Provo River: The Provo River Subunit is divided into two populations, the Heber Valley and the Upper Provo. Weekly monitoring within the Heber Valley population began on 24 March and continued to 20 May (Table 3). Egg masses were first discovered within the lower reaches of the Heber Valley population on 2 April and breeding peaked approximately four weeks later on 2 April. A total of 640 egg masses were observed within the Heber Valley (Figure 3). The lower reaches (1-4) accounted for 228 egg masses (35.6%), middle reaches (5-6) 25 egg masses (3.9%), and the upper reaches (7-9) 387 egg masses (60.5%).

Monitoring of the Upper Provo River population began on 23 April and continued until 19 May. Egg masses were first reported on 23 April and peaked on 6 May (Table 3). With the combined efforts of the Central and Northern regions of the UDWR a total of 476 egg masses were observed within the Upper Provo River population (Figure 4). The Shady Dell repatriation site was also surveyed for egg masses and/or juvenile Columbia spotted frogs. No egg masses or juveniles were found. Repatriation efforts of the Shady Dell site continued in 2008. One half portions of 15 egg masses were collected from Taylor's Fork egg deposition sites (Upper Provo population), transported to the Northern Region office, hatched and released into suitable habitat at Shady Dell.

Jordan River: No surveys were conducted in the Jordan River subunit in 2008, but a dead Columbia spotted frog was found at the River's Bend Golf Course near the Jordan River in Riverton (Peter Hovingh pers. comm.). No pictures or samples were collected, but given the biologist's familiarity with Columbia spotted frogs it is unlikely the specimen was misidentified.

Upper Weber: Two surveys of the Swaner Nature Preserve repatriation site were conducted in 2008. Four egg masses were discovered. All were located at "Big Pond" approximately 100m north of the original Beta repatriation site. Four sweep surveys were also conducted within other wetland complexes near Park City and the Timber Lakes (west of Heber City) areas. No Columbia spotted frogs or egg masses were discovered during the sweep surveys. Repatriation efforts continued in 2008 with the release of over 250 tadpoles from the Heber Valley population directly into suitable habitat. An additional 490 tadpoles were placed in head-start cages (70 per cage) at Alpha, Beta, and Heather Pond. On August 11, approximately 50 metamorphs were released (mean snout-vent length 25.86mm, survivorship 10%).

Repatriation efforts also began at the Taylor's Fork site located within the Wasatch-Cache National Forest east of Kamas. Half portions of 15 egg masses were collected from the North Fork Upper Provo population, hatched at the Northern Region UDWR office, and released into suitable habitat at Taylor's Fork. Repatriation efforts will continue for at least the next two years.

Lower Weber: No surveys were conducted within the subunit in 2008.

Sevier River GMU

San Pitch River: Monitoring of the Fairview population within the San Pitch River Subunit began on 3 April and continued through 16 May. The first egg masses were estimated to be laid on 14 April and breeding likely peaked approximately ten days later on 24 April (Table 3). A total of 19 egg masses were observed within the subunit (Figure 5).

West Desert GMU

Ibapah Valley: Monitoring within the Ibapah Valley commenced on 17 April and continued through 1 May (Table 3). Egg masses were first observed within the Ibapah Valley on 17 April and breeding is estimated to have peaked five to seven days earlier. A total of 267 egg masses were observed within the subunit, but due to miscommunication the traditional South site was not monitored. Over 200 egg masses were discovered at other sites within the valley (South n=NA, New North n=55, other sites n=212) (Figure 6).

Snake Valley: Monitoring within Snake Valley subunit was conducted from 10 March through 9 April with a total of 436 egg masses observed (Table 3). One hundred and sixty five egg masses were discovered at Leland Harris, 246 at Miller Springs, and 25 within the SITLA owned parcel south of the traditional monitoring area (Figure 7). Due to time and personnel constraints only a small portion of the SITLA wetland was surveyed. Breeding within the subunit began the week of 20 March and peaked approximately one week later.

Tooele Valley: Monitoring within the Tooele Valley began on 10 March (Table 3). For the fourth year in a row no egg masses or adults were observed (Figure 8). One sweep survey was also conducted within the subunit at the Fitzgerald Wildlife Management

Area (Atherly Reservoir) near Faust, Utah. No Columbia spotted frog egg masses or adults were detected during the survey

2007 Chytrid Monitoring
Mouthpart Abnormalities: Of all tadpoles examined 513 (97.5%) were *normal,* eight (1.5%) tadpoles expressed *slight* abnormalities, and five (1.0%) expressed *severe* abnormalities.

PCR/Abnormality Methods Comparison: In an attempt to elucidate concerns regarding the accuracy of mouthpart abnormalities to accurately categorize *Bd* infection a random sample of 48 tadpoles were collected and classified as *Bd* positive or negative based on mouthpart abnormalities and also analyzed by PCR analysis (Table 4). Six of 48 (12.5%) randomly selected tadpoles tested positive for *Bd* using PCR analysis. Proper diagnosis via mouthpart abnormalities was hampered by a large amount of both type 1 (false positive) and 2 errors (false negative).

Sensitivity and specificity of *severe* mouthpart designation are 17% and 95% (Table 4). Approximately 5% of *Bd* negative animals would have been designated positive based on *severe* mouthpart abnormalities. Eighty-three percent of *Bd* positive animals would have been designated negative based on *severe* mouthpart abnormalities. True prevalence of *Bd* (via PCR) was 12.5% and observed prevalence utilizing *severe* designation was 6.25%. When compared to PCR analysis s*evere* abnormality designation correctly identified infection status 85.4% of the time.

Sensitivity and specificity of *slight* mouthpart designation are 66.7% and 64.3% Table 4). Approximately 36% of *Bd* negative animals would have been designated positive based on severe mouthpart abnormalities. Thirty-three percent of *Bd* positive animals were designated negative based on severe mouthpart abnormalities. True prevalence of *Bd* (via PCR) was 12.5% and observed prevalence utilizing *slight* designation was 39.58%. When compared to PCR analysis slight abnormality designation correctly identified infection status 64.6% of the time.

2008 Chytrid Monitoring
In the Wasatch Front GMU, *Bd* was not discovered in the Spanish Fork River subunit during the 2008 surveys, but the results are based on a very small representative sample (Table 5). In the Utah Lake subunit, *Bd* was discovered on nine of the ten samples tested (Table 5). Additionally, 40% of the samples collected within the Provo River subunit tested positive for *Bd* (Table 5). In the Swaner Nature Preserve, metamorphs from the head-start experiment were swabbed and seven of the 45 tested positive for the presence of *Bd* (Table 5).

In the Sevier River GMU, Columbia spotted frogs and northern leopard frogs (*Lithobates pipiens*) within the subunit were swabbed for *Bd*, but the results were not available prior to the publication of this report (Table 5).

DISCUSSION

Cumulative Columbia spotted frog egg mass numbers within the Central Region of UDWR continue to be below the average of the previous ten years despite the discovery of several new breeding sites (Figure 9). One should exercise caution when interpreting annual monitoring results. Although UDWR strives to maintain comparable methods, each monitoring season nonetheless varies temporally and spatially. Many amphibians exhibit high natural fluctuations in breeding size and recruitment (Berven 1990; Skelly et al. 1999). Such variation in breeding populations (and therefore egg production) may be the result of drought conditions from previous years or other natural variables and not necessarily due to increasing habitat degradation and other threats (Berven 1990; Skelly et al. 1999).

Amphibian populations throughout the West face an increasing number of anthropomorphic threats to their recruitment and survivorship. These threats include, but are not limited to, habitat destruction, degradation, and fragmentation due to urban development, agriculture (farming and grazing), and water development and diversion projects. In addition amphibians face predation and competition from an increasing number of nonnative species, including nonnative game fish (such as brown trout, *Salmo trutta*), virile (*Orconectes virilis*) and red swamp crayfish (*Procambarus clarkia*), Western mosquitofish (*Gambusia affinis*), plains (*Fundulus zebrinus*) and rainwater killifish (*Lucania parva*), and American bullfrogs (*Rana catesbeiana*). In addition to predation and competition many of these nonnative species serve as vectors for diseases and pathogens such as *Bd* and *Ranavirus* (Daszak et al. 2004; Daszak et al. 1999). Typically, it is not just one of these factors which causes population decline, but their combined synergistic effects. Management recommendations outlined for each GMU are not intended to be an exhaustive list of needed conservation actions, but are only intended to serve as timely priorities and goals to guide conservation actions in the following year. For a more extensive list of conservation actions that are needed to insure the long term preservation of the species, please review the Conservation Agreement and Strategy for Columbia Spotted Frog in the State of Utah (Perkins and Lentsch 1998, Bailey et al. 2006).

Wasatch Front GMU

Spanish Fork: For the second time in four years no egg masses were encountered at Holladay Springs in 2007. However, egg masses were encountered the following year, 2008. Average egg mass production over the past five years (mean=2.2) is lower than those encountered in the previous ten years (1993-2002, mean=80 egg masses) (Figure 1). The last years of relatively strong recruitment were during 2001 and 2002.

The Holladay Springs population has become isolated from other regional populations and may now be isolated from other potential sources of adult immigration. Such isolation is detrimental in several ways. It inhibits migration of adults to more favorable habitats during conditions of drought (or other disturbances). During periods of prolonged drought survivorship and recruitment of amphibians can be reduced or even eliminated (Dodd 1993). Despite the relatively long life span of Columbia spotted frogs (Turner 1960), populations cannot tolerate extended periods of poor recruitment without

declining. While such variability in amphibian breeding production is not unusual (Berven 1990), isolated populations are slow to recover since they do not benefit from immigration from other populations (Marsh and Trenham 2001). Reproductive isolation and low effective population sizes may also lead to inbreeding depression due to the increased expression of deleterious alleles and increased influence of genetic drift (Beebee and Rowe 2001). Such events may reduce adult fitness and juvenile recruitment leading to a reduction in population size (Rowe and Beebee 2003).

Egg mass numbers (n_{2007}=15, n_{2008}=10) at the Springville Hatchery population are comparable to those seen in the previous few years (Figure 1), but are still lower than the previous ten year average of approximately 30 egg masses per year. Springville egg mass counts display a declining trend similar to those seen at Holladay Springs (Figure 1). Columbia spotted frog habitat at the Springville Hatchery is also isolated and fragmented. The reduction in egg mass numbers may be attributable to the same factors as at Holladay Springs, those primarily being habitat degradation and fragmentation. The Springville population is likely also being affected by the changes in hydrology and water quality associated with urbanization of the surrounding watershed (Riley et al 2005; Paul and Meyer 2001; Wilson and Dorcas 2003). Over 80 young of the year spotted frogs were released within the Springville population in 2004 as part of a head-start program. The majority of the cohort should reach sexual maturity by 2008. We were optimistic the head-start efforts would result in increased reproductive output in 2008 but surveys did not reveal a noticeable increase in egg mass production.

Egg mass numbers at Diamond Fork are down slightly from those of the previous two years (Figure 1). Lower egg mass values in the first two years of monitoring (2003-2004) are likely attributable to a smaller search effort, but 2005-2008 sampling efforts are comparable. Despite the slight reduction we are still optimistic about the future of the Diamond Fork population and believe the reduction in egg mass totals observed this year is attributable to natural variability within the population. We were hopeful that the release of over 40 metamorphosed frogs during 2005 head-start efforts would help bolster the population and result in increased egg production in 2008 and 2009 as they reach sexual maturity but 2008 surveys did not reveal an increase in egg mass production (Bailey et al. 2006).

Recent changes in the hydrology of Diamond Fork Creek associated with the implementation of the Diamond Fork Water Delivery System (part of the Central Utah Project) warrant close monitoring of the system. Completion of the project will reduce discharge within Diamond Fork Creek to flows more similar to its natural hydrograph (Trihey and Associates 1997). Since 1915 the flows of Diamond Fork Creek have been altered by water conveyance projects. It is uncertain how such alterations have effected amphibian populations, and it remains to be seen how the recent alterations will impact the local Columbia spotted frog population. The proposed reduced flows may increase the suitability of the stream as a migration corridor, but in contrast, reduced discharge may reduce flood dependent and off channel habitat such as oxbow ponds (Hepworth and Wiley 2006). Currently Columbia spotted frog breeding is limited to the lower two kilometers of Diamond Fork Canyon. Habitat restoration may be necessary to create

suitable Columbia spotted frog habitat in other portions of the drainage to facilitate expansion of the population. Current restoration plans being formulated by the URMCC and UDWR will conservatively double the available amount of breeding habitat. Restoration efforts, including the creation of an extensive wetland complex, are scheduled to commence in the spring of 2009.

Utah Lake: Egg masses observed within the Mona Springs and South of Burraston population increased in 2007 and 2008 to the highest number of egg masses observed in the past seven years (n_{2007}=88, n_{2008}=99; Figure 2). Fifty-five egg masses were observed at the South of Burraston sites, the remaining 33 were within Mona Springs sites. It is encouraging to see an increase in production within the population but efforts should continue to mitigate threats to the population. Most of these threats have already been discussed in detail in reference to other populations; these include isolation due to habitat fragmentation, altered hydrology, and previous years of drought.

In addition to these factors the Mona Springs and the South of Burraston complex Columbia spotted frog populations must compete with and avoid predation by a large number of exotic fish. Within the system there are at least six exotic fish species, including mosquitofish, fathead minnow (*Pimephales promelas*), plains killifish, rainwater killifish, common carp (*Cyprinus carpio*), and *Lepomis* sp. (Crockett and Mills 2006). Annual least chub (*Iotichthys phlegethontis*) monitoring surveys conducted at Mona Springs reveal non-native fish comprise over 75% of all fish collected (Crockett and Mills 2006). Cyprinodontiformes and cyprinids can drastically reduce recruitment by preying on amphibian larvae (Gamradt and Kats 1996; Baber and Babbitt 2004; Goodsell and Kats 1999). Mosquitofish, which accounted for over 40% of all fish captured over the past five years at Mona Springs (Crockett and Mills 2006), are efficient predators and their impacts upon amphibian populations are well documented (Gamradt and Kats 1996; Baber and Babbitt 2004; Goodsell and Kats 1999).

An additional threat to the Mona Springs population was discovered in 2007. An adult American bullfrog was captured within a current Columbia spotted frog breeding site. Stomach contents of the bullfrog revealed the presence of two partially digested Columbia spotted frog, both believed to be at least age-2 or age-3. The detrimental effects of American bullfrogs upon native amphibian communities have been widely documented (Moyle 1973; Doubledee et al. 2003; Kiesecker et al. 2001). Limited information exist regarding consumption rate of American bullfrogs upon other amphibians, but one study found even relatively small introduced bullfrogs (mean approximately 90g) may be able to consume over 3 grams of native anurans a day (Wang et al. 2007). Based on such information one adult bullfrog could consume two to three age-0 metamorphs (0.7-1.3 grams each) or one to two age-1 or older Columbia spotted frog a day. Although predation upon Columbia spotted frogs in a complex habitat such as Mona Springs would be highly variable and dependent upon feeding efficiency and prey density, a few bullfrogs could have an impact upon the population. In 2009, UDWR will continue removal of bullfrogs from Mona Springs. In addition to predation and competition bullfrogs can also prove detrimental to other amphibians by serving as pathogen and parasite vectors (Daszak et al. 2004; Daszak et al. 1999).

Through head-start efforts, over one hundred metamorphs were released in 2004, and an additional 21 in 2005 (Wilson et al. 2005). Assuming the majority of Columbia spotted frog females reach maturity at no earlier than age 3-4 (Reaser 2000), the metamorphs released in 2004 should reach sexual maturity in 2007-2008 and the 2005 metamorphs in 2008-2009. The majority of these individuals should be sexually mature by spring of 2008 and may have contributed to the seven year high in egg mass production seen in 2008 surveys.

Provo River: The second highest egg mass total on record was observed in the Heber Valley in 2007 (*n*=800) (Figure 3) and is well above the average of the previous ten years (1996-2006, $\bar{x}$=573). However, survey efforts in 2008 discovered only 640 egg masses, a reduction from the previous four years (Figure 3). Parallel efforts by the URMCC recorded substantially more egg masses (n_{2007} = 927, n_{2008} = 1,040). The discrepancies may be the result of streamlined UDWR methods that reduced the frequency of monitoring visits to each site by approximately 50% (see Methods and Materials). The goal of the streamlined method was two fold: 1) to reduce the amount of resources expended on the Heber population in order to utilize those resources for other populations and 2) locate 80% of the egg masses located during full scale (weekly) monitoring. In 2007 and 2008 the streamlined monitoring conducted by UDWR was able to locate 86% and 62% (respectively) of the egg masses detected by the full scale monitoring conducted by the URMCC. Streamlined methods accomplished both goals in 2007 but 2008 efforts failed to locate 80% of the egg masses located during full scale (weekly) monitoring. There are several possible reasons why full scale URMCC surveys detect more egg masses than UDWR's streamlined methods, these include: 1) URMCC surveys are conducted over a greater period of time and may record a greater number of egg masses, 2) UDWR surveyors mark egg mass deposition sites with surveyor's tape, which may increase URMCC's ability to detect deposition sites (URMCC surveyors do not mark sites), and 3) Varying experience levels of UDWR personnel may result in variable detection probabilities, particularly in complex habitat.

The total number of egg masses recorded within the Upper Provo population in 2007 (n=559) increased from those observed in 2006 and is above the average observed in the previous five years (2002-2006, $\bar{x}$= 466) (Figure 4). In 2008, the total number of egg masses recorded within the Upper Provo population (n=476) decreased slightly from the number observed in 2007 and fell below the average observed in the previous five years (2003-2007, $\tilde{}$ = 526; Figure 4). A portion of the recent increase can be attributed to the discovery of new monitoring sites within the subunit, for example one site discovered in 2006 now accounts for 30-40 egg masses annually. The population is threatened by residential development within the watershed. Several studies have examined the impacts of watershed urbanization upon amphibians (Paul and Meyer, 2001; Wilson and Dorcas, 2003; Riley et al. 2005). Urbanization detrimentally affects an ecosystem in several ways including altered hydrology, increased fragmentation and migration barriers, and the increased loading of nutrients, sediment, and pollutants (Paul and Meyer 2001). Significant impact to amphibian communities can occur when as little as 8% of the watershed has been altered (Riley et al. 2005). It is uncertain what percent of the

Upper Provo watershed has been altered, but development will continue to encroach upon suitable habitat and migration corridors. The establishment of a conservation easement in 2004 with Victory Ranch (a resort community encompassing over 5,600 acres and approximately 5 miles of the Provo Rive) should serve as at template for conservation amidst development. The easement helps ensure the continued protection of the Upper Provo populations of Columbia spotted frogs. When possible UDWR will continue to pursue such agreements and preserve Columbia spotted frog habitat.

Upper Weber River: Survey efforts in 2008 resulted in the first documentation of successful head-start and reintroduction efforts which were initiated in 2006. These efforts confirmed the first record of Columbia spotted frog within the area in the past 40 years. Surveys in 2008 revealed four Columbia spotted frog egg masses at the Swaner Nature Preserve repatriation site and resulted in the capture of one adult (Table 3). All egg masses were discovered at "Big Pond" approximately 100 m north of the original Beta release site. Repatriation efforts at Swaner Nature Preserve began 2004 with the release of approximately 731 age-0 sub-adults into the wetland complex. The population was augmented in 2006 with the addition of approximately 4,000 tadpoles. The founding population at Swaner Nature Preserve is comprised of egg masses from the Heber Valley and Upper Provo River population.

Repatriation efforts continued in 2008 via head-start efforts with 490 tadpoles and the direct release of approximately 250 tadpoles into suitable habitats. Survivorship within the head-start cages (10%) was lower than previous efforts but a portion is attributable to escape due to torn and dislodged cages as opposed to mortality. Released metamorphs were comparable in size to other studies and could make a substantial contribution to future recruitment. Several of the metamorphs tested positive for *Bd,* but at the time of release did not express deleterious symptoms (Table 5). The effects of *Bd* upon Columbia spotted frog populations are not well understood and should be closely monitored.

Sevier River GMU

San Pitch River: The number of egg masses observed within the Fairview Columbia spotted frog population declined for the fourth (2007) and fifth (2008) consecutive years (Figure 5). Although some monitoring sites were not sampled because of access problems, the majority of individual breeding locations have undergone similar rates of decline. Known Columbia spotted frog habitat is isolated by agricultural and residential development. Additionally, the San Pitch River floodplain, where the majority of the population resides, is heavily impacted by water diversions, beaver eradication, and intense grazing. Preservation and protection of existing habitat and the establishment of migration corridors between the sites is necessary to sustain the current population. Many of the known breeding locations currently support fewer than ten adults (<5 egg masses) and may not be able to recover from localized extinction events. In addition without gene flow between local habitats the population may suffer from the deleterious effects of a population bottleneck. UDWR is currently negotiating easements with two landowners in the region and examining the suitability of the property for habitat

restoration efforts. UDWR will continue to pursue easements and agreements with private landowners to protect and improve Columbia spotted frog habitat.

West Desert GMU

Ibapah Valley: The number of egg masses observed at monitoring sites within the Ibapah Valley increased from 198 in 2006 to 229 in 2007 (Figure 6). Totals at the newly established North #2 site increased from 59 in 2006 to 74 egg masses in 2007 and decreased to 55 in 2008. Totals at the South monitoring site (n=155) in 2007 were comparable to the previous two years but continue to be substantially lower than historical highs seen in 1999-2001 (Figure 6). In 2008, a total of 212 egg masses were discovered but the traditional South sites were not included in the survey. Determining the long term population trend is complicated by the addition of a new monitoring site in 2006 (North #2). A miscommunication led to the surveying of other sites within the subunit which were incorrectly thought to be the traditional South sites. One site located on BLM owned lands held 44 Columbia spotted frog egg masses. Efforts were made to initiate joint sampling efforts with the Confederated Tribes of the Goshute Indian Reservation, but representatives were unable to participate.

Within the Ibapah Valley habitat degradation due to livestock grazing continues to be problematic. The deleterious effects of livestock grazing upon vertebrate animals in the West are well documented (for review see Fleischner 1994). Poorly managed grazing can be especially detrimental to aquatic ecosystems by direct trampling, loss of natural riparian vegetation, decreased bank stability, increased sedimentation, and increased nutrient input (and subsequent eutrophication) (Rouse et al 1999; Fleischner 1994; Clary and Kinney 2002). Efforts will continue to pursue potential conservation easements and grazing management plans with area landowners. Such proactive efforts will help insure the continued connectivity of Columbia spotted frog populations within the valley. Efforts will also continue in 2009 to involve the Confederated Tribes of the Goshute Indian Reservation with monitoring.

Snake Valley: The total number of egg masses observed within the Snake Valley (Leland Harris and Miller Springs combined) during 2007 (n=487) and 2008 (n=411) is the lowest total recorded since monitoring began in 1995 and considerably below the long term average of the previous ten years (1996-2006 $\bar{x}$=1380 egg masses) (Figure 7). Total egg masses within Leland Harris decreased in 2007 and 2008 to its lowest recorded annual total and is below the ten year average of 539 egg masses a year. At Miller Springs, the number of egg masses recorded in 2007 (n=246) were the second lowest ever recorded and were considerably below the ten year average of 850 egg masses. It is unclear why the reproductive output of the population has decreased when compared to the period between 1998 and 2002. It has been suggested that hydrologic conditions during the periods of peak egg mass production were more conducive to breeding. Although such a statement may be true, it is very difficult to prove by examining local precipitation records, in fact 2005 was the wettest year on record since 1998, but did not result in correspondingly high egg mass totals or the following season in 2006 (Figure 10). Without further study we can only speculate as to the reason for the decline in the population and try to mitigate potential threats. Livestock grazing on both properties

should be closely monitored and grazing management plans should be pursued with the private landowner.

In 2008, a partial survey of the SITLA owned wetlands south of Leland Harris revealed 25 Columbia spotted frog egg masses. The area surveyed only represents approximately 10% of the wetland complex. The full parcel should be surveyed in 2009 to establish a baseline for future annual or biennial monitoring. The parcel is hydrologically connected to the historic Leland Harris monitoring site and contains similar habitat types.

Tooele Valley: For the past four years egg masses have not been observed in the Vernon Columbia spotted frog population (Figure 8). Habitat conditions at the site are marginal with sporadic open water and limited suitable overwintering habitat. This population may no longer be present. In 2007 and 2008, sweep surveys were conducted at Fitzgerald Wildlife Management Area (Atherly Reservoir) in an attempt to locate other Columbia spotted frog populations and identify potential translocation sites within the subunit. Despite our survey efforts, no egg masses or frogs were discovered. UDWR will conduct additional surveys in the area in 2009 and continue to monitor the Vernon population.

Chytrid Monitoring

The Heber Valley population currently appears to be stable and benefiting from the extensive preservation and restoration efforts implemented by the URMCC, UDWR, and other partners. Despite the indication of a stable population several threats still exist. In 2001, the population tested positive for *Bd* and the long term consequences of infection are poorly understood. Chytrid has been attributed to the decline in amphibian populations in the west (Muths et al. 2003) and an epizootic event resulting in the decline of the Columbia spotted frog population within the Heber Valley was originally feared, but never occurred. Recent studies suggest a population may be able to persist with *Bd* infection, but subsequently suffer mortality due to combined stressors such as altered habitat (Collins and Storfer 2003, Briggs et al. 2005, Kriger and Hero 2006)

Since 2004, Columbia spotted frog tadpoles have been monitored for mouthpart abnormalities and depigmentation as an indication of *Bd* infection throughout the valley (see Fellers et al. 2001). Because of the high cost of analyzing PCR samples ($15-30 per sample), UDWR has routinely used this method of documenting mouthpart abnormalities as a proxy for *Bd* infection. Utilizing this method in 2007, the percentage of symptomatic tadpoles with any abnormality decreased from 2.5% compared to 3.8% in 2006. The relatively low rate of infection based on mouthpart abnormalities is cautiously encouraging, but several factors remain unknown. Abnormalities may be caused by factors other than *Bd* infection, including stress, pollution, and may be species specific (Padgett-Flohr and Goble 2007; Rowe et al. 1998).

When compared to PCR analysis s*evere* abnormality designation correctly identified infection status 85.4% of the time and *slight* abnormality correctly identified infection status 64.6% of the time, but both suffered from high rates of false negatives and false positives. Of the 48 samples in the comparison only six (12.5%) tested positive for *Bd*

using PCR analysis. The low sample size and low number of actual *Bd* positive samples (based on PCR analysis) may have confounded the results and not provided an accurate comparison of the methodologies, but other studies have found similar discrepancies. Padgett-Flohr and Goble (2007) conducted a similar test with over 2000 tadpoles and documented prevalence of *Bd* based on mouthpart abnormalities. Given the variability in infection status between the methodologies one should be very cautious when using mouthpart abnormalities as a substitute for PCR analysis. Until further species specific studies are conducted UDWR should not rely upon mouthpart abnormalities to reliably diagnose *Bd* infection in Columbia spotted frogs.

Management Recommendations

Wasatch Front GMU

1) Evaluate the importance of Holladay Springs and the Springville population to the long term preservation of the Wasatch Front GMU. The loss of any local population is deplorable, but the two populations are potentially isolated from the local metapopulation and may not be able to support viable populations. Efforts to sustain them may or may not represent the best use of limited resources. The genetic diversity and divergence of the population should be determined to help prioritize conservation actions.
2) Work with other agency partners to design and implement the creation of additional habitat in the spring of 2009.
3) Identify potential corridors for migration to ensure genetic diversity is maintained within the Holladay Springs and Springville populations.
4) Pursue funding opportunities to restore and create additional Columbia spotted frog habitat within Diamond Fork Canyon.
5) Continue the removal of American bullfrogs from the Mona Springs Columbia spotted frog site and evaluate effectiveness of removal methods (i.e., gigging, shooting).
6) Pursue conservation easements (and potential acquisition via conservation partners) with private landowners to secure viable migration corridors between Mona Springs and South of Burraston sites.
7) Continue to explore options to control nonnative fish and amphibian species within the Utah Lake watershed.
8) Continue restoration efforts within the middle reaches (reach 4-6) of the Provo River.
9) Prioritize private lands in proximity to the Upper Provo population and pursue conservation easements with interested landowners.
10) Continue repatriation efforts at Taylor's Fork (Upper Weber subunit) and Shady Dell (Provo subunit) utilizing the Upper Provo population as a source population for repatriation.
11) Discontinue the use of mouthpart abnormality to determine *Bd* infection status.
12) Continue repatriation efforts at the Swaner Nature Preserve in 2009, releasing an additional 25-50 metamorphs.
13) Partner with Swaner Nature Preserve to introduce logs, root wads, and other structures to increase habitat complexity (especially overwintering habitat).

14) Continue outreach and education efforts with Swaner Nature Preserve and other interested parties.

Sevier River GMU

1) Prioritize areas for establishment of conservation easements and continue to pursue partnerships to preserve, enhance, and connect suitable habitat.
2) Pursue partnerships with the Natural Resources Conservation Service (NRCS) to enhance and create Columbia spotted frog habitat adjacent to the San Pitch River floodplain.
3) Collect 30-60 *Bd* samples from Columbia spotted frogs and/or northern leopard frogs to better ascertain the prevalence and rate of infection.

West Desert GMU

1) Pursue conservation easement and grazing management plans/agreements with private landowners.
2) Coordinate with the BLM to implement habitat restoration and grazing enclosures within Columbia spotted frog habitat
3) Coordinate with the Confederated Tribes of the Goshute Indian Reservation to involve representatives in monitoring and pursue funding for a tribal egg mass monitoring technician and habitat restoration projects.
4) Conduct full egg mass surveys of the SITLA owned wetlands south of Leland Harris to establish a baseline for future annual or biennial monitoring.
5) Petition the addition of the SITLA Leland Harris parcel to UDWR's priority lands acquisition list and pursue its acquisition from SITLA.
6) Continue to pursue conservation easements and grazing management plans with private landowners within Snake Valley.
7) Collect 30-60 *Bd* samples from Columbia spotted frogs and/or other amphibians within the Snake Valley subunit to better ascertain the prevalence and rate of infection.

LITERATURE CITED

Ammon, E. M. 2001. The roles of habitat creation, natural colonization, and relocation in recovering the Wasatch front population of the Columbia spotted frog (Rana luteiventris). Final Report to the Biological Resources Division of the U.S. Geological Survey, Species-At-Risk Program.

Annis, S. L., F. D. Dastoor, H. Ziel, P. Daszak, and J. E. Longcore. 2004. A DNA-based assay identifies *Batrachochytrium dendrobatidis* in amphibians. *Journal of Wildlife Diseases*. 40(3):420-428.

Bailey, C. L., K. W. Wilson, and M. E. Andersen. 2006. Conservation Agreement and Strategy for Columbia Spotted Frog (*Rana luteiventris*) in the State of Utah. Utah Division of Wildlife Resources Publication. Salt Lake City, Utah.

Baber, M. J. and K. J. Babbitt. 2004. Influence of Habitat Complexity on Predator–Prey Interactions between the Fish (*Gambusia holbrooki*) and Tadpoles of *Hyla squirella* and *Gastrophryne carolinensis*. *Copeia* 2004(1):173-177.

Beebee, T. and G. Rowe. 2001. Application of Genetic Bottleneck Testing to the Investigation of Amphibian Declines: A Case Study with Natterjack Toads. *Conservation Biology* 15(1):266-270.

Belk, M. and E. Harvey. 2005. Development Study Plan for Repatriation of the Wasatch Front Columbia Spotted Frog (*Rana luteiventris*). Unpublished report presented to the Columbia Spotted Frog Conservation Team.

Berven, K.A. 1990. Factors Affecting Population Fluctuations in Larval and Adult Stages of the Wood Frog (*Rana sylvatica*). *Ecology* 71(4):1599-1608.

Blaustein, A.R., D.G. Hokit, and R.K. O'Hara. 1994. Pathogenic fungus contributes to amphibian losses in the Pacific Northwest. *Biological Conservation* 67(1994):251-254.

Blaustein, A. R., J. M. Romansic, E. A. Scheessele, B. A. Han, A. P. Pessier, and J. E. Longcore. 2005. Interspecific variation in the susceptibility of frog tadpoles to the pathogenic fungus *Batrachochytrium dendrobatidis.* *Conservation Biology* 19(5):1460-1468.

Briggs, C.J, V.T. Vredenburg, R.A. Knapp, and L.J. Rachowicz. 2005. Investigating the population-level effects of chytridiomycosis: An emerging infectious disease of amphibians. *Ecology* 86: 3149–3159.

Carey, C. 1993. Hypothesis concerning the cause of the disappearance of boreal toads from the mountains of Colorado. *Conservation Biology* 7:355-362.

Clary, W. P. and J. W. Kinney. 2002. Streambank and vegetation response to simulated cattle grazing. *Wetlands* 22(1):139-148.

Collins, J. P. and A. Storfer. 2003. Global amphibian declines: sorting the hypothesis. Diversity and Distributions 9:89-98.

Crockett, C.P. and M. Mills. 2006. Least Chub (*Iotichthys phlegethontis*) Monitoring Summary Central Region 2006. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Crump, M. L. and N. J. Scott, Jr. 1994. Visual encounter surveys. *In* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster (eds), Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians, pp. 84-92. Smithsonian Institution Press, Washington DC.

Daszac, P., L. Berger, A. Cunningham, A. D. Hyatt, D. E. Green, and R. Speare. 1999. Emerging infectious diseases and amphibian population declines. *Emerging Infectious Diseases* 5(6):735-748.

Daszac, P., A. A. Cunningham, and A. D. Hyatt. 2001. Anthropogenic environmental change and the emergence of infectious diseases in wildlife. *Acta Tropica* 78(2):103-116.

Daszak, P., A., A. A. Strieby, J. E. Cunningham, C. C. Longcore, Browne, and D. Porter. 2004. Experimental evidence that the bullgrog (*Rana catesbeiana*) is a potential carrier of chytridiomycosis, an emerging fungal disease of amphibians. *Herpetological Journal* 14:201-207.

Demlong, M. 1999. Beyond captive propagation. *Endangered Species Bulletin* 34(3): 22-24.

Docherty, D.E., C.U. Meteyer, J.Wang, J. Mao, S.T. Case, and V.G. Chinchar. 2003. Diagnostic and molecular evaluation of three Iridovirus-associated salamander mortality events. *Journal of Wildlife Diseases* 39(3):556-566.

Doubledee, R. A., E. B. Muller, R. M. Nisbet. 2003. Bullfrogs, disturbance regimes, and the persistence of California red-legged frogs. Journal of Wildlife Management 67(2):424-438.

Dodd, C.K. 1993. Cost of living in an unpredictable environment: the ecology of striped newts (*Notophthalmus perstriatus*) during a prolonged drought. *Copeia* 1993(3):605-614.

Fellers, G.M., D. E. Green, and J.E. Longcore. 2001. Oral Chytridiomycosis in the Mountain Yellow-Legged Frog (*Rana mucosa*). *Copeia* 2001(4):945-953.

Fleischner, T.L. 1994. Ecological costs of livestock grazing in Western North America. *Conservation Biology* 8(3):629-644.

Gamradt, S. C. and L. B. Kats. 1996. Effect of introduced crayfish and mosquitofish on California newts. Conservation Biology 10(4):1155-1162.

Goodsell, J. A., and L. B. Kats. 1999. Effects of introduced mosquitofish on Pacific treefrogs and the role of alternative prey. Conservation Biology 13(4):921-924.

Hepworth, R.D. and D.E. Wiley. 2006. Abundance and Distribution of Leatherside Chub in Diamond Fork Creek. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Hovingh, P. 1993. Aquatic habitats, life history observations, and zoogeographic considerations of the spotted frog (*Rana pretiosa*) in Tule Valley, Utah. *Great Basin Naturalist* 53(2):168-179.

Jancovich, J.K, E.W. Davidson, N. Parameswaran, J. Mao, G. Chinchar, J.P. Collins, B.L. Jacobs, and A. Storfer. 2005. Evidence for the emergence of an amphibian iridoviral disease because of human-enhanced spread. *Molecular Ecology* 14(1):213-224.

Kendell, K. 2001. Northern Leopard Frog Reintroduction: Raven River –Year 2 (2000). Alberta Sustainable Resource Development, Fish and Wildlife Service, Alberta Species at Risk Report No. 13, Edmonton, AB.

Kiesecker, J. M., A. R. Blaustein, and C. L. Miller. 2001. Potential mechanisms underlying the displacement of native red-legged frogs by introduced bullfrogs. Ecology 82(7):1964-1970.

Kriger, K.M., and J. M. Hero. 2006. Large-scale seasonal variation in the prevalence and severity of chytridiomycosis. *Journal of Zoology* 271: 352–359.

Longcore. J. E., A. P. Pessier, and D. K. Nichols. 1999. *Batrachochytrium dendrobatidis* gen. et sp. nov., a chytrid pathogenic to amphibians. *Mycologia* 91(2):219-227.

Marsh, D. M. and P.C. Trenham. 2001. Metapopulation Dynamics and Amphibian Conservation. *Conservation Biology* 15(1):40-49.

Muths, E., P. S. Corn, A. P. Pessier, and D. E. Green. 2003. Evidence for disease-related amphibian decline in Colorado. *Biological Conservation* 110(3):357-365.

National Climatic Data Center (NCDC). 2006. Weather and Climate Events Website. http://www.ncdc.noaa.gov/oa/ncdc.html. Asheville, NC.

Paul, M. J. and J. L. Meyer. 2001. Streams in urban landscapes. *Annual Review of Ecology and Systematics* 32(2001):333-365.

Padgett-Flohr, G. E. and M. E. Goble. Evaluation of tadpole mouthpart depigmentation as a diagnostic test for infection by *Batrachochytrium dendrobatidis* for four California anurans. *Journal of Wildlife Diseases* 43(4): 690-699.

Perkins, J. M. and L. D. Lentsch. 1998. Conservation Strategy for Spotted Frog. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Reaser, J.K. 2000. Demographic analyses of the Columbia spotted frog (*Rana luteiventris*): case study in spatio-temporal variation. *Canadian Journal of Zoology* 78:1158–1511

Riley, S. P. D., G. T. Busteed, L. B. Kats, T. L. Vangergon, L. Lee, R. Dagit, J. Kerby, R. Fisher, and R. Sauvajot. 2005. Abundance of amphibians and invasive species in Southern California streams. *Conservation Biology* 19(6):1894-1907.

Ross, D. A., K. McDonald, and D. L. Shirley. 1993. Western Spotted Frog Distribution (*Rana pretiosa)* in Western Utah, Field Report. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Ross, D. A., M. C. Stanger, K. McDonald, D. L. Shirley, P. A. White, and L. L. Lentsch. 1994. Distribution, Habitat Use, and Relative Abundance Indices of Spotted Frogs in the West Desert, Utah, 1993. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Rouse, J. D., C. A. Bishop, and J. Struger. 1999. Nitrogen Pollution: An Assessment of Its Threats to Amphibian Survival. *Environmental Health Perspectives* 107(10):799-803.

Rowe, C. L., O. M. Kinney, J. D. Congdon. 1998. Oral deformities in tadpoles of the bullfrog (*Rana catesbeiana*) caused by conditions in a polluted habitat. *Copeia* 1998(1):244-246.

Rowe, G. and T.J.C. Beebee. 2003. Population on the verge of a mutational meltdown? Fitness costs of the genetic load for an amphibian in the wild. *Evolution* 57(1)177-181.

Sjogren, P. 1991. Extinction and isolation gradients in metapopulations: the case of the pool frog (*Rana lessonae)*. *Biological Journal of the Linnean Society* 42(1-2): 135-147.

Skelly, D. K., K. L. Yurewicz, E. E. Werner, and R. A. Relyea. 2003. Estimating decline and distributional change in amphibians. *Conservation Biology* 17(3):744-751.

Sredl, M.J. 2000. A fungus amongst frogs. *Sonoran Herpetologist* 13(11):122-125.

Sredl, M.J., K.J. Field, and A.M. Peterson. 2002. Mitigating threats and managing the Ramsey Canyon leopard frog in Arizona. Nongame and Endangered Wildlife Program Technical Report 207. Arizona Game and Fish Department, Phoenix, Arizona.

Thompson, P. and B. Schmitz. 1998. Amphibian surveys in the Northern Region, 1997. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Thompson, P., B. Nadolski, and P. Chase. 2003. Boreal toad (*Bufo boreas boreas*) and spotted frog (*Rana luteiventris*) distributional surveys and monitoring in Northern Utah, 2002. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Thurnheer, S. and H.U. Reyer. 2000. Spatial distribution and survival rate of waterfrog tadpoles in relation to biotic and abiotic factors: a field experiment. *Amphibia-Reptilia* 22: 21-32.

Trihey and Associates, Inc. 1997. Preliminary Restoration Plan for Sixth Water Creek: Final Report. Trihey & Associates, Inc. 4180 Treat Boulevard, Concord, CA.

Turner, F.B. 1960. Population structure and dynamics of Western Spotted Frog, Rana. P. pretiosa Baird & Girard, in Yellowstone Park, Wyoming. *Ecological Monographs* 30(3):251-278.

Wang, Y., Z. Guo, C. A. Pearl, Y. Li. 2007. Body size affects the predatory interactions between introduced American bullfrogs (*Rana catesbeiana*) and native Anurans in China: an experimental study. Journal of Herpetology 41(3): 514-520.

Willson, J. D. and M. E. Dorcas. 2003. Effects of habitat disturbance on stream salamanders: implications for buffer zones and watershed management. *Conservation Biology* 17(3):763-771.

Wilson, K.W. and R. Olsen. 2001. Columbia Spotted Frog (*Rana luteiventris*) Population Monitoring Summary Central Region, 2001. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Wilson, K. W., C. M. Davidson, E. M. DuRoss. 2003. Columbia Spotted Frog (*Rana luteiventris*) Population Monitoring Summary Central Region, 2003. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Wilson, K.W., P. Thompson, M.D. Mills, and E.M. DuRoss. 2005. Columbia Spotted Frog (*Rana luteiventris*) Monitoring Summary Northern and Central Region, 2005. Utah Division of Wildlife Resources. Salt Lake City, Utah.

Wilson, K.W. 2002. Columbia Spotted Frog (*Rana luteiventris*) Monitoring Summary Central Region 2002. Utah Division of Wildlife Resources. Salt Lake City, Utah.

TABLES

Table 1. Central region and northern region Columbia spotted frog monitoring dates and historic breeding onset for 2008. The historical onset of breeding as estimated from the "Mean Date of Breeding" is provided along with the approximate date that each sentinel site was monitored. "Visit #1" and "Visit #2" denotes the days after the historical onset of breeding that each site was monitored for 2008.

GMU	HUC	Population	Mean Date of Breeding	Sentinel Monitoring Begins	Visit #1 (Days After)	Visit #2 (Days After)
Wasatch Front	Spanish Fork River	Diamond Fork	3/28	3/21	14	21
		Holladay Springs	3/17	3/10	14	21
		Springville	3/22	3/15	14	21
	Utah Lake	Burraston	3/27	3/20	14	21
		Mona Springs	3/25	3/18	14	21
	Provo River	Heber Valley North	3/28	3/21	7	14
		Heber Valley South	3/24	3/17	7	14
		Upper Provo	3/26	3/19	10	17
Sevier River	San Pitch	Fairview	3/28	3/21	14	21
West Desert	Ibapah Valley	Ibapah	3/20	3/13	14	21
	Snake Valley	Leland Harris	3/13	3/6	14	21
		Miller Springs	3/16	3/9	14	21

Table 2. Central and Northern Region Columbia spotted frog monitoring schedule and summary 2007. Sites are represented by the geographic management unit (GMU), hydrologic unit (HUC), and the name of the sample site (population) of interest. Dates approximate (*).

GMU	HUC	Population	Monitoring		Breeding		Total Egg Masses	HUC Totals
			Starts	Ends	Starts	Peaks		
Wasatch Front	Spanish Fork River	Holladay Springs	3/13	4/13	NA	NA	0	107
		Springville Hatchery	3/16	4/12	3/24	4/5	15	
		Diamond Fork	3/19	4/16	4/17	4/19	92	
	Utah Lake	Mona Springs	3/13	4/5	3/11	3/23	33	88
		Burraston Ponds	3/20	4/12	3/18	3/20	55	
	Provo River	Upper Provo River	4/2	4/27	3/31	4/11	559	1359
		Heber Valley	3/26	4/18	3/24	4/4	800	
Sevier River	San Pitch River	Fairview	3/22	4/18	3/20	3/22	31	31
West Desert	Ibapah Valley	New North	3/29	4/17	4/1	4/4	74	229
		South	3/29	4/17	4/2	4/4	155	
	Snake Valley	Leland Harris	3/1	4/10	3/14	3/16	241	487
		Miller Springs	3/1	4/9	3/13	3/28	246	
	Tooele Valley	Vernon	3/23	4/10	NA	NA	NA	0
		Atherly	4/23	4/27	NA	NA	NA	

Table 3. Central and northern region Columbia spotted frog monitoring schedule and summary for 2008. Estimates based on current egg development, temperature, and development rates of similar habitats are denoted with an asterisk (*). Only a small portion of the SITLA wetland complex was surveyed (**); the Snake Valley egg mass total does not include the 25 egg masses observed at SITLA which were not considered part of the annual monitoring sites.

GMU	HUC	Population	Monitoring		Breeding		Total Egg Masses	HUC Totals
			Starts	Ends	Starts	Peaks		
Wasatch Front	Spanish Fork River	Holladay Springs	4/4	4/28	3/15	3/22	2	89
		Springville Hatchery	4/16	4/17	4/1	4/8	10	
		Diamond Fork	4/4	4/21	4/1	4/4	77	
	Utah Lake	Mona Springs	3/19	4/28	3/26	4/4	58	99
		S. Burraston Ponds	4/14	4/30	4/1	4/8	41	
	Provo River	Upper Provo River	4/23	5/19	4/20	5/6	476	1122
		Heber Valley	3/24	5/20	3/28	5/2	640	
		Wallsburg	4/29	4/29	4/14	4/17	6	
	Upper Weber	Swaner Preserve	5/7	5/27	5/5	5/10	4	4
Sevier River	San Pitch River	Fairview	4/3	5/16	4/14	4/24	19	19
West Desert	Ibapah Valley	New North	4/17	5/1	4/2	4/10	55	267
		South	NA	NA	NA	NA	NA	
		Other	4/17	5/1	4/2	4/10	212	
	Snake Valley	Leland Harris	3/11	4/10	3/20	3/26	165	411**
		Miller Springs	3/10	4/9	3/20	3/25	246	
		SITLA**	3/26	3/26	3/20	3/26	25	
	Tooele Valley	Vernon	4/10	4/10	NA	NA	0	0
		Atherly	4/10	4/10	NA	NA	0	

Table 4. Mouthpart abnormality and PCR Batrachochytrium dendrobatidis analysis comparison. *Bd* condition results are based on PCR analysis (*). Observed prevalence refers to visual observation obtained from mouthpart inspection.

Severe Designation Comparison			Slight Designation Comparison		
	Bd Condition*			*Bd* Condition*	
	Absent	Present		Absent	Present
Test Positive	2	1	Test Positive	15	4
Test Negative	40	5	Test Negative	27	2
Prevalence (PCR)	0.125		Prevalence (PCR)	0.125	
Observed Prevalence	0.063		Observed Prevalence	0.396	
Sensitivity	0.167		Sensitivity	0.667	
Specificity	0.952		Specificity	0.643	

Table 5. Columbia spotted frog *Batrachochytrium dendrobatidis* sample results for 2008. The number of samples taken in the Sevier River are combined for *Rana luteventris* and *Lithobates pipiens* (*); additionally, FES has not completed the analysis and the results are incomplete.

GMU	HUC	Population	Sample Number	*Bd* Positive
Wasatch Front	Spanish Fork River	Diamond Fork	4	0
	Provo River	Heber Valley	25	10
	Utah Lake	Mona Springs	10	9
	Upper Weber	Swaner	45	7
Sevier River	San Pitch River	Fairview	62*	NA**

FIGURES

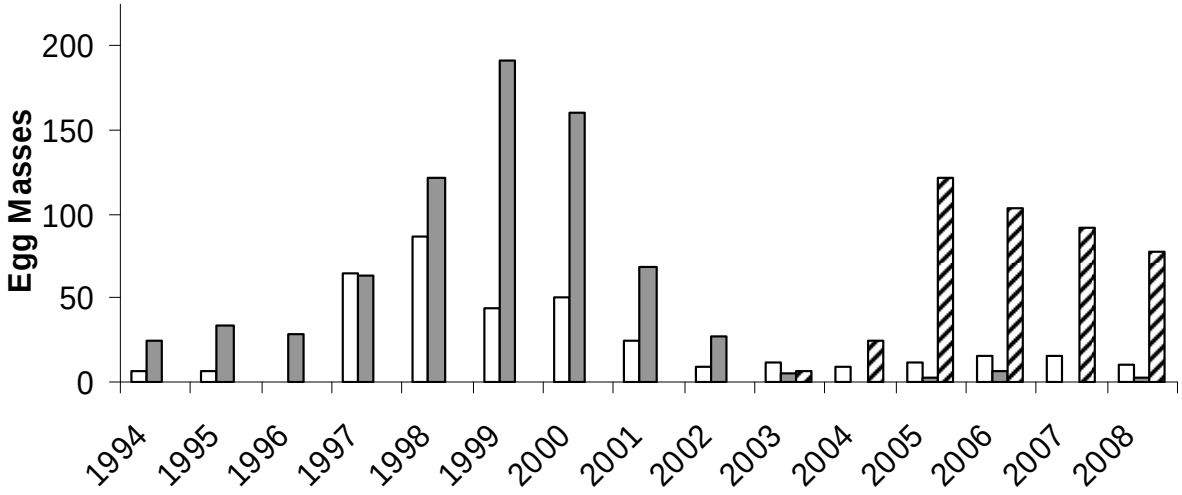

Figure 1. Total number of egg masses observed in the Spanish Fork River subunit, 1994-2008. Egg mass totals for the Springville population are shown in white, Holladay in grey, and Diamond Fork in stripes.

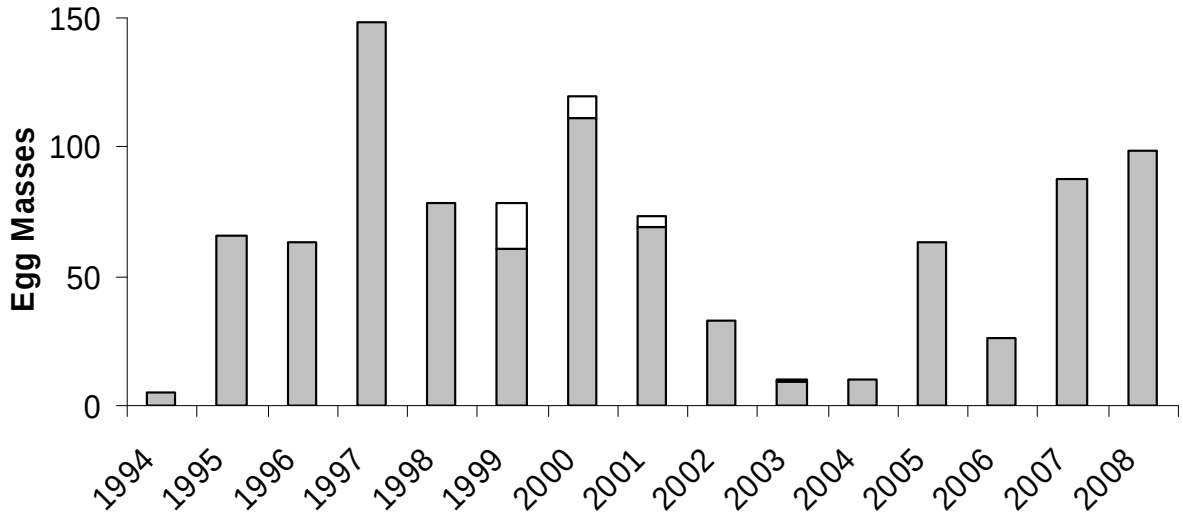

Figure 2. Total number of egg masses observed in the Utah Lake subunit: South of Burraston and Mona Springs populations combined for 1994-2008. Monitoring sites are shown in grey and sweep sites are in white.

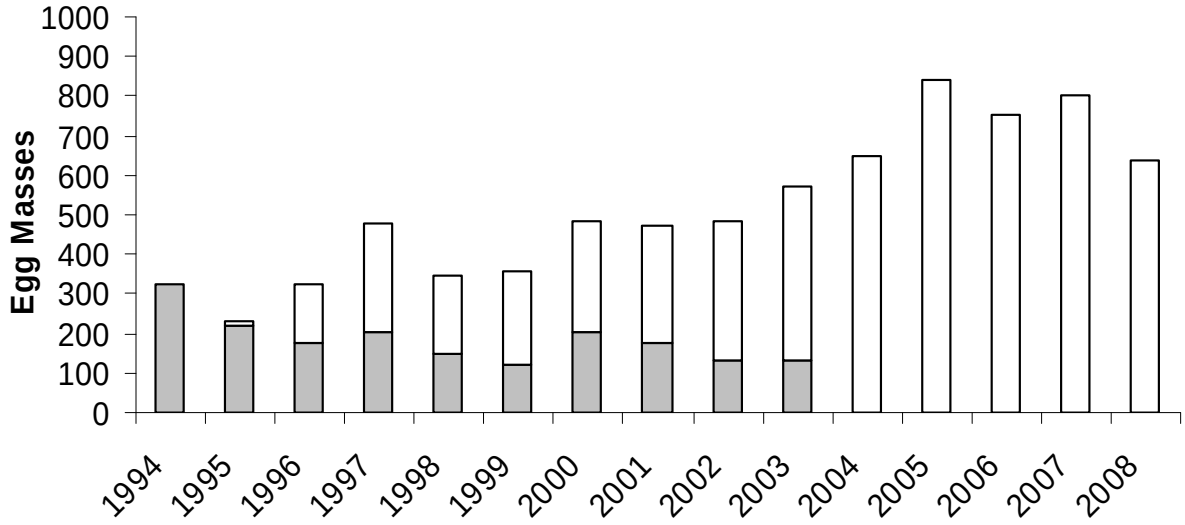

Figure 3. Total number of egg masses observed in the Provo River subunit, Heber Valley population for 1994-2008. Monitoring sites are shown in grey and sweep sites are in white.

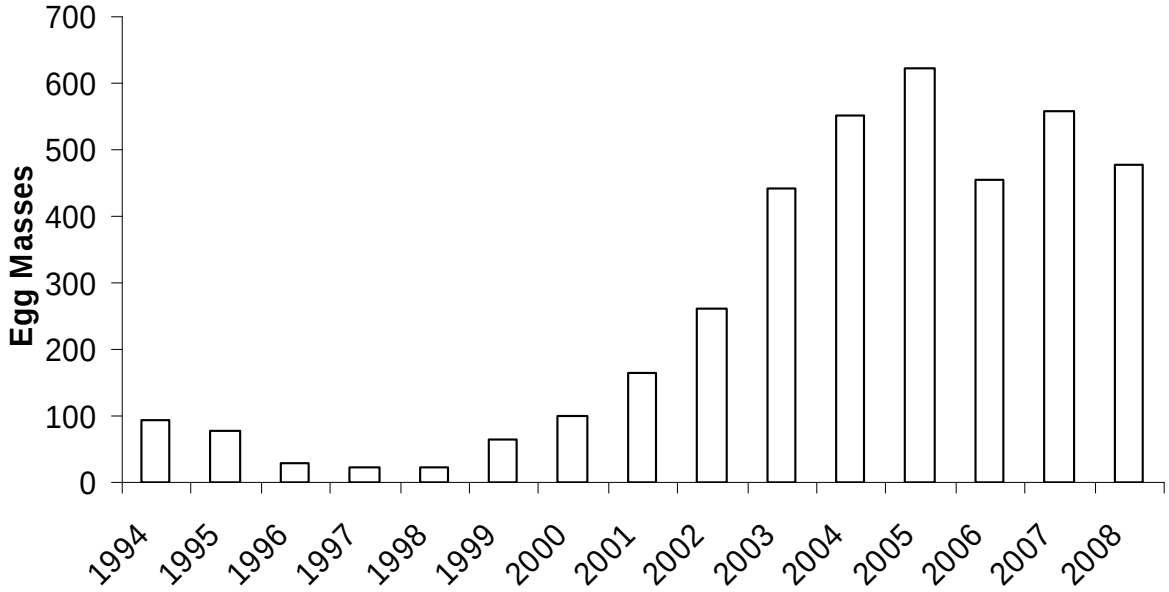

Figure 4. Total number of egg masses observed in the Provo River subunit, Upper Provo River population 1994-2008.

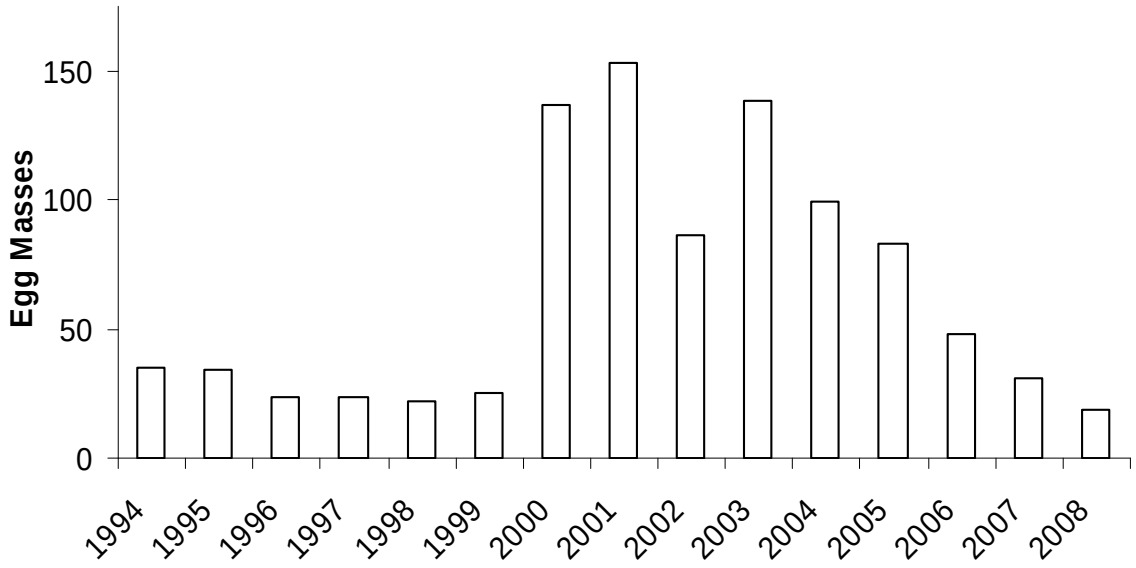

Figure 5. Total number of egg masses observed in the San Pitch River subunit: Fairview population for 1994-2008.

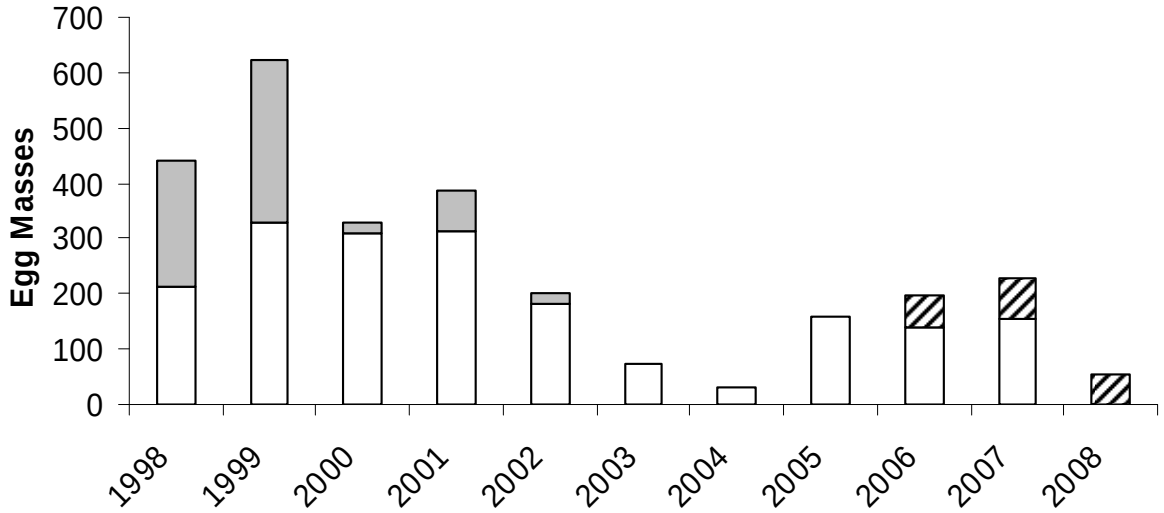

Figure 6. Total number of egg masses observed in the Ibapah Valley subunit for 1998-2008. Egg mass totals for the South site population are shown in white, North #1 in grey, and North #2 in stripes. South site population was not surveyed in 2008.

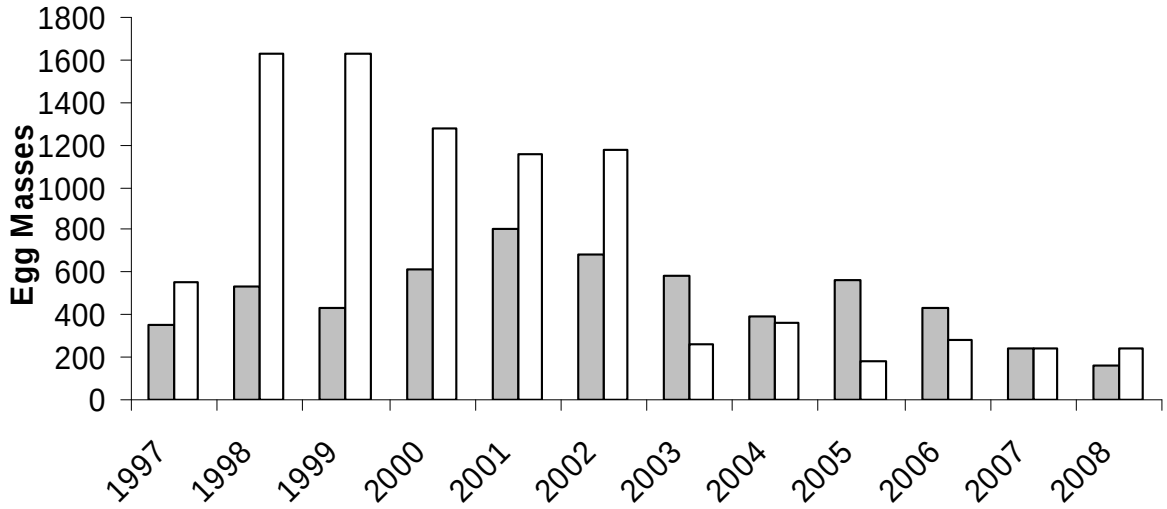

Figure 7. Total number of egg masses observed in the Snake Valley subunit for 1997-2008. Egg mass totals for Leland Harris are shown in grey and Miller Springs in white.

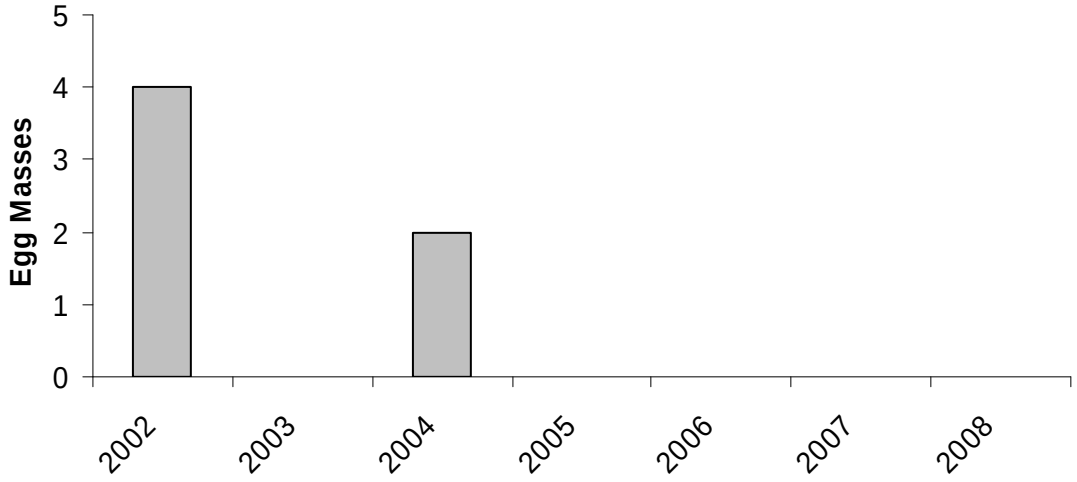

Figure 8. Total number of egg masses observed in the Tooele Valley subunit for 2002-2008.

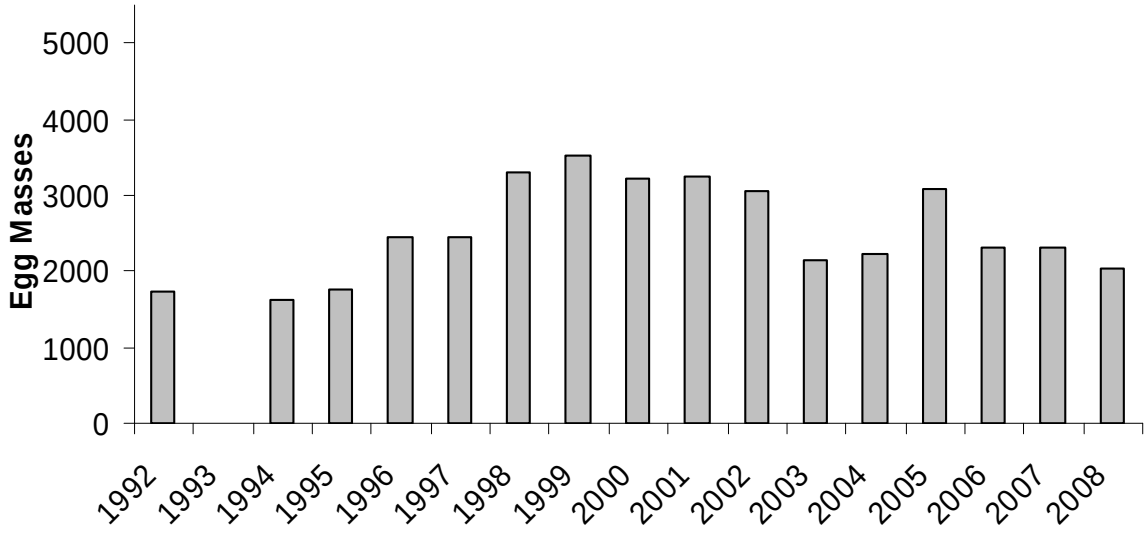

Figure 9. Central Region cumulative Columbia spotted frog egg masses for 1996-2008.

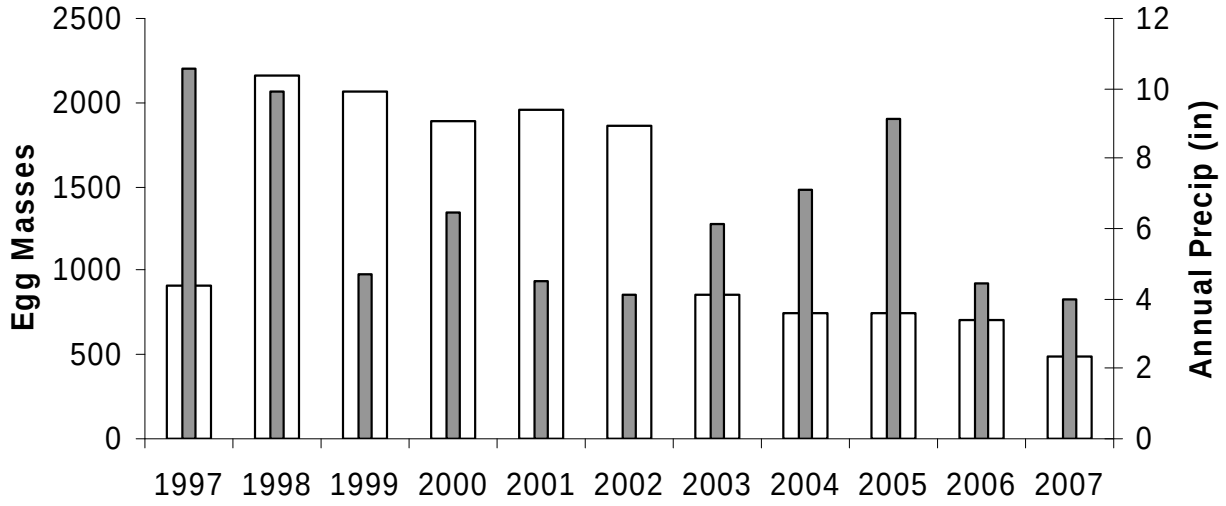

Figure 10. Total annual precipitation and egg mass totals in the Snake Valley subunit from 1992-2007. Precipitation data compiled from the National Climatic Data Center website (NCDC 2007). Total number of egg masses from Snake Valley is shown in white and total annual precipitation from Callao is shown in grey.

State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife Resources - Native Aquatic Species

Columbia Spotted Frog Population Monitoring Summary & Conclusions: Tule & Southern Snake Valleys, 2007-2008

II-Southern Region Report

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E. Jordanna Black, Aaron D. Geheber, Callie A. W. Grover, Arlis Jones, Joshua D. Kreitzer, Jan K. Boyer, Eric R. Castro, Amos H. Rehm, Brian J. Roller, Casey R. Smith, Kiira J. Siitari, and Laura K. Tomlinson of Utah Division of Wildlife Resources, Gretchen M. Baker and Meg A. Horner of Great Basin National Park, and Hugh Hurlow of Utah Geological Survey.

COMMENTS

In spring, 2007 and 2008, the Utah Division of Wildlife Resources conducted the tenth and eleventh consecutive year of Columbia spotted frog monitoring in southern Snake Valley and Tule Valley, Utah. The objective of this ongoing effort is to monitor Columbia spotted frog populations and their habitat trends.

METHODS

Spotted frog surveys in spring 2007 and 2008 were conducted at Beck Springs, Bishop Springs, Gandy Marsh, and Tule Valley. Monitoring sites were selected based on historical records and previous annual population monitoring. In addition, United States Geological Survey 7.5 minute topographic maps and Geographical Positioning System (GPS) units were used to locate habitat areas and plot Universal Transverse Mercator (UTM) coordinates.

Visual encounter surveys were conducted at each site by walking transects along the banks and in shallow water searching for egg clusters, defined as egg masses located in close proximity (less than 0.3 m) to one another. Egg mass age class and number of masses were recorded for each site.

Sites were visited regularly during the breeding period (first visit: 4-6 March, second visit: 17-20 March, third visit: 24-28 March, fourth visit: 2-3 April) to locate new egg masses, track survival of previously encountered masses, and ensure that monitoring was conducted during the peak period of egg deposition. Masses were classified into five developmental age class categories: *age class 1* - mass below water surface and resting on substrate or vegetation, envelopes clear and ova small, dark, and circular; *age class 2* - mass starting to float to surface, envelopes opaque and ova kidney-shaped or elongated; *age class 3* - mass often at water surface with top layer of eggs crusty due to desiccation, embryos have tails and are close to hatching; *age class 3+* - mass starting to disarticulate and often yellow in color, half or more of the embryos have hatched and are feeding on the mass or swimming freely as tadpoles; and *dead* - embryos white, with disarticulation of both the embryos and the egg mass.

Egg mass counts were used to determine relative abundance and to estimate the number of breeding adults in the population. Breeding population size was calculated to facilitate comparison with previous studies. If we assume an equal sex ratio, that breeding females oviposit only one egg mass per year, and each egg mass is the product of a single breeding pair,

then doubling the number of egg masses detected during a single breeding season can provide an approximation of breeding population size.

RESULTS, DISCUSSION, & RECOMMENDATIONS

Beck Springs

A total of 82 spotted frog egg masses were observed in Beck Springs during spring 2007 monitoring (Table 1 and 2), resulting in an estimated breeding population of 164. In 2008, a total of 120 spotted frog egg masses were observed during spring 2008 monitoring (Table 1 and 2), resulting in an estimated spotted frog breeding population of 240. In 2007, for the first time since the population was discovered in 2005, Columbia spotted frog eggs were discovered at South Beck Springs. The number of spotted frog eggs observed during spring 2008 was higher than any year since the population was discovered in 2005 (Table 2, Figure 1). Additional spotted frog breeding habitat may be created at South Beck Spring by increasing the depth of the outflow pool.

Bishop Springs

A total of 891 spotted frog egg masses were observed in Bishop Springs during spring 2007 monitoring (Table 1 and 2) resulting in an estimated breeding population size of 1,782 individuals. The number of spotted frog egg masses observed in 2007 is higher than any year since 1998. In 2008, a total of 715 spotted frog egg masses were observed during spring monitoring (Table 1 and 2), resulting in an estimated breeding population size of 1,430 individuals. Although the number of spotted frog egg masses observed in 2008 is lower than 2007, it remains higher than any year since 1998 (Table 2, Figure 2).

Gandy Marsh

A total of 114 spotted frog egg masses were counted in Gandy Marsh during spring 2007 monitoring (Table 1 and 2), resulting in an estimated breeding population size of 228 individuals. A total of 128 spotted frog egg masses were counted during spring 2008 monitoring (Table 1 and 2), resulting in an estimated breeding population size of 256 individuals. Numbers of egg masses observed at Gandy are comparable to numbers observed the previous five years, but are significantly lower than pre 2002 levels (Table 2, Figure 3). There was overlap in spotted and leopard frog egg deposition at Gandy Marsh, and relatively high numbers of juvenile and adult leopard frogs were observed. Little is known about the potential implications of leopard frog and spotted frog living sympatrically, these interactions should be evaluated at Gandy Marsh to determine if any adverse affects may result from sympatric living.

Tule Valley

A total of 2,131 spotted frog egg masses were documented during spring 2007 monitoring (Table 1, 2, and 3), resulting in an estimated breeding population size of 4,262 individuals. In 2008, a total of 2,302 spotted frog egg masses were documented during spring monitoring (Table 1, 2, and 3), resulting in an estimated breeding population size of 4,604 individuals. The number of egg masses observed in Tule Valley in 2007 and 2008 is comparable to those observed in previous years (Table 2, Figure 4). Egg masses at Tule 7 (Coyote Springs) comprised 50% (2007) and 46% (2008) of all egg masses observed in Tule Valley (n_{2007} = 1,072; n_{2008} = 1,066).

During the 2007 and 2008 surveys egg masses were not observed in Tule 8. In 2007, egg masses were not observed in Tule 4b (Table 3). In 2008, after tamarisk and sediment removal, small portions (10–20 eggs) of 60 egg masses from Tule 1, Tule 2, Tule 4a, and Tule 4b were translocated to Tule 8. These sites will be monitored in subsequent years to determine the success of the translocation.

The Tule Valley spotted frog population is currently stable, however spotted frog breeding habitat could be vulnerable to succession of spring complexes and livestock grazing impacts. Additionally, succession of tamarisk at Tule 7 (Coyote Spring) may pose a long-term threat, making the removal and control of tamarisk a high priority. Finally, a population of introduced tropical aquarium platy fish (*Xiphophorus maculatus*) was discovered in Tule 4a. The potential impacts of introduced fish on spotted frog populations should be further evaluated.

TABLES

Table 1. Total number of spotted frog egg masses observed by age class ("AC"), including tadpole mortalities ("Dead"), for the survey sites of the southern Snake and Tule Valleys, 2007 and 2008. Masses were classified into five developmental AC categories: AC 1 - mass below water surface and resting on substrate or vegetation, envelopes clear and ova small, dark, and circular; AC 2 - mass starting to float to surface, envelopes opaque and ova kidney-shaped or elongated; AC 3 - mass often at water surface with top layer of eggs crusty due to desiccation, embryos have tails and are close to hatching; AC 3+ - mass starting to disarticulate, often yellow in color, half or more of the embryos have hatched and are feeding on the mass or swimming freely as tadpoles; Dead - embryos white, with disarticulation of both the embryos and egg mass.

Site	AC 1		AC 2		AC 3 & 3+		Dead		Total	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Beck	21	89	11	31	50	0	0	0	82	120
Bishop	282	683	72	13	525	19	12	0	891	715
Gandy	63	88	37	23	13	15	1	2	114	128
Tule Valley	1089	1520	410	473	576	230	56	79	2131	2302

Table 2. Total number of spotted frog egg masses found by the survey sites in southern Snake and Tule Valleys for the years 1997 - 2008.

Site	Beck	Bishop	Gandy	Tule Valley
1997	Not surveyed	Not surveyed	406+	1451
1998	Not surveyed	275	1545	441
1999	Not surveyed	274	672	1220
2000	Not surveyed	241	784	1631
2001	Not surveyed	201	585	2072
2002	Not surveyed	357	90	2203
2003	Not surveyed	615	115	3870
2004	Not surveyed	213	131	1326
2005	Not surveyed	325	155	2158
2006	89	425	205	2397
2007	82	891	114	2131
2008	120	715	128	2302

Table 3. Total number of spotted frog egg masses observed by age class (AC) at individual springs in Tule Valley, spring 2006.

Site	AC 1		AC 2		AC 3 & 3+		Dead		Total	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Tule 1	211	177	0	1	0	0	0	1	211	179
Tule 2	54	37	5	0	0	0	0	0	59	37
Tule 3	114	292	96	24	77	31	1	0	288	347
Tule 4A	109	204	22	7	148	29	1	0	280	240
Tule 4B	0	24	0	3	0	0	0	0	0	27
Tule 4C	0	13	0	0	0	0	2	0	2	13
Tule 5	90	66	56	281	1	31	50	2	197	381
Tule 6	11	0	1	1	10	10	0	1	22	12
Tule 7	500	706	230	156	340	129	2	75	1072	1066
Tule 8	0	0	0	0	0	0	0	0	0	0
Total for Tule Valley	1089	1520	410	473	576	230	56	79	2131	2302

FIGURES

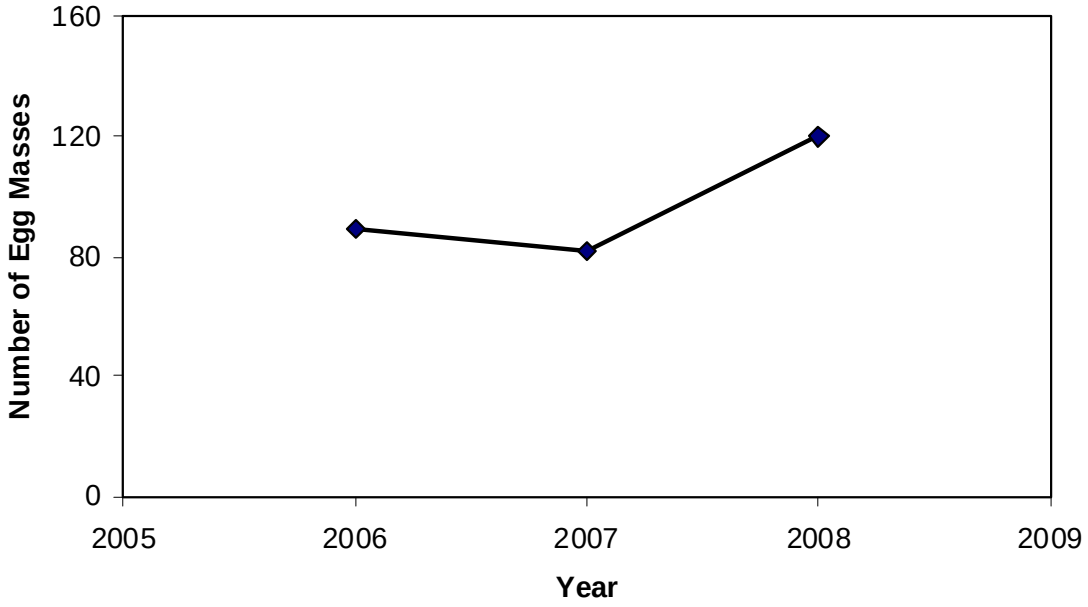

Figure 1. Number of spotted frog egg masses observed during annual monitoring from 2006-2008 at Beck Springs, Utah.

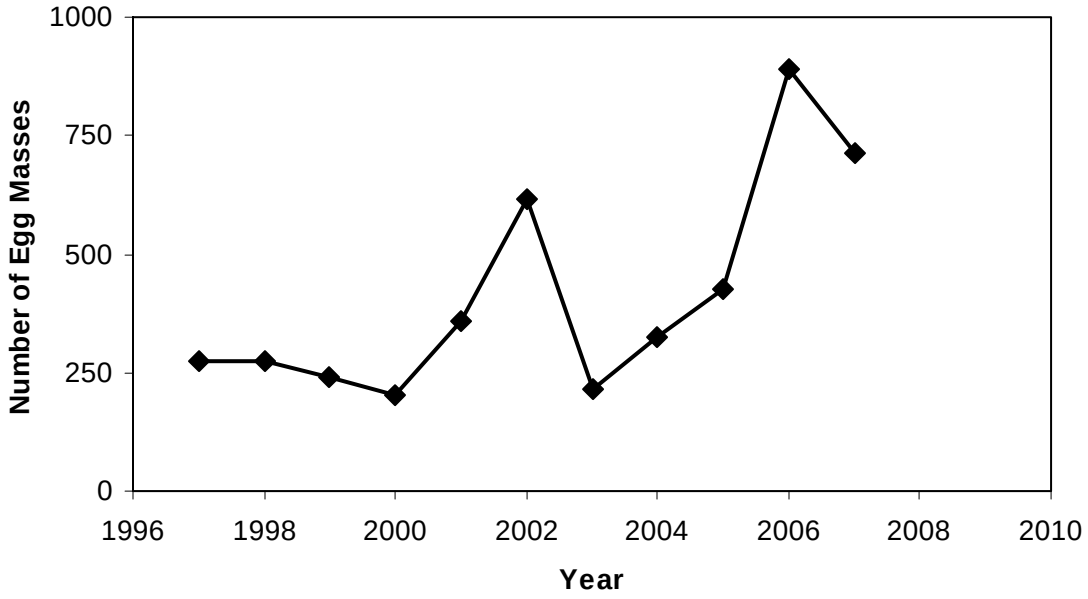

Figure 2. Number of spotted frog egg masses observed during annual monitoring from 1997 to 2008 at Bishop Springs, Utah.

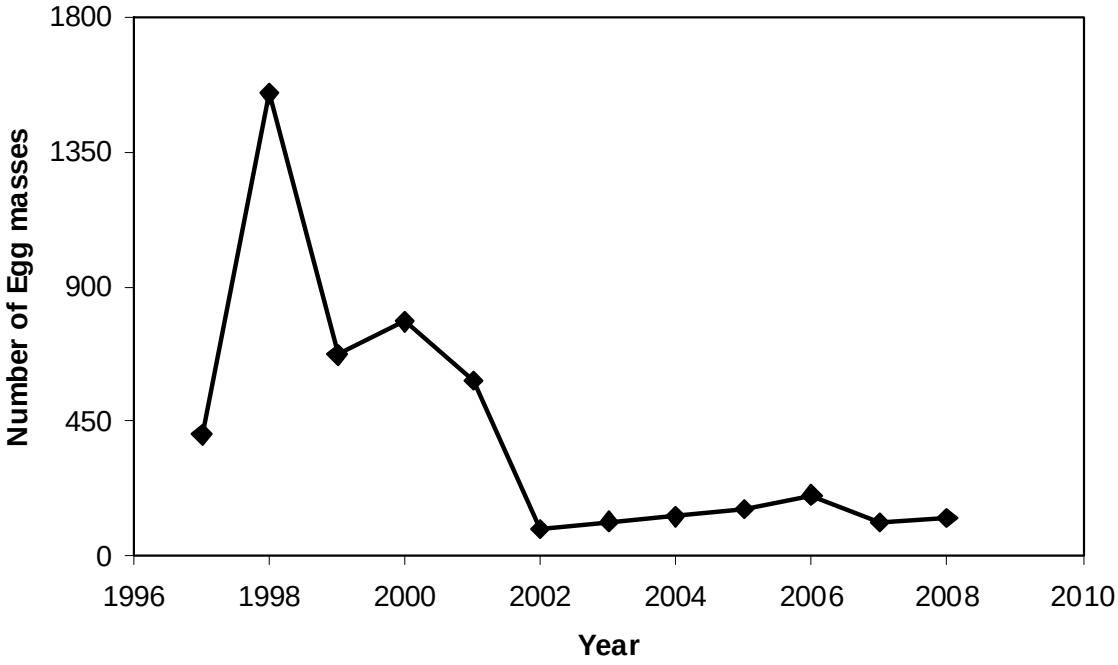

Figure 3. Number of spotted frog egg masses observed during annual monitoring from 1997 to 2008 at Gandy Marsh, Utah.

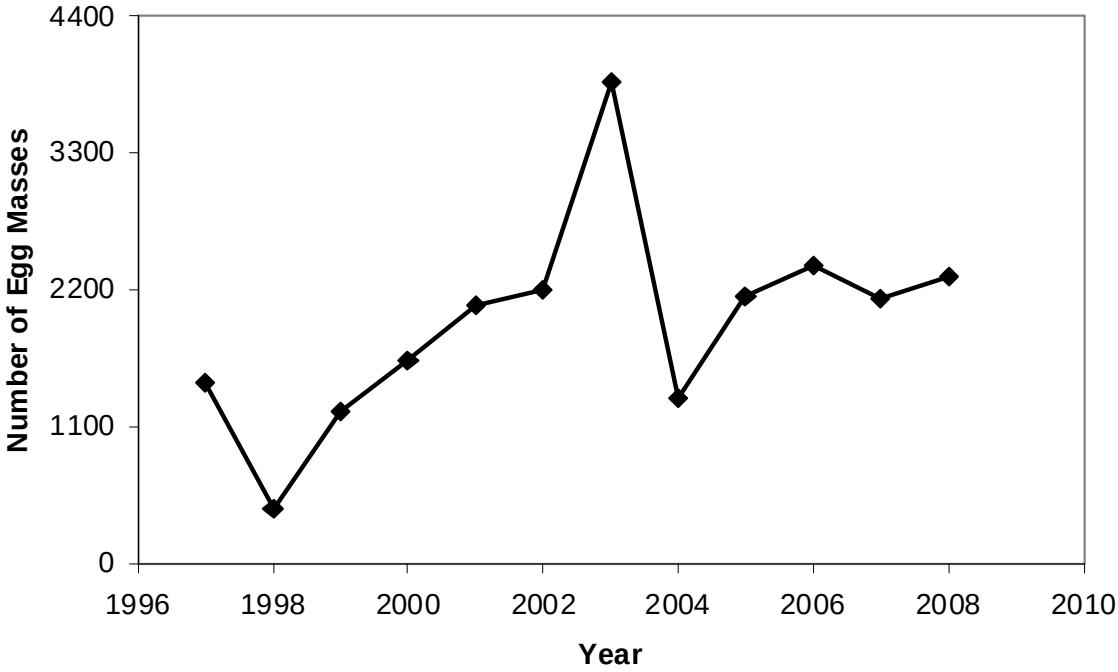

Figure 4. Number of spotted frog egg masses observed during annual monitoring from 1997 to 2008 at Tule Valley, Utah.